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## A Comprehensive Clinical Evaluation of 20,000 Persian Gulf War Veterans

Stephen C. Joseph, MD MPH\* and the Comprehensive Clinical Evaluation Program Evaluation Team†

In response to the health concerns of Gulf War veterans, the Department of Defense instituted the Comprehensive Clinical Evaluation Program (CCEP). Although not designed as a research study, the CCEP provided valuable clinical data. An analysis was conducted of CCEP findings from systematic and comprehensive examinations of 20,000 U.S. Gulf War veterans. Among 20,000 participants, the types of primary and secondary diagnoses varied widely. Also, among veterans with an ICD-9-CM diagnosis of "symptoms, signs, and ill-defined conditions," no single subcategory of illness predominated, and no characteristic physical sign or laboratory abnormality was identified. In total, there were 74 (0.4%) cases of connective

tissue disease; 52 (0.3%) noncutaneous malignancies; 42 (0.2%) peripheral neuropathies; 14 (0.07%) cases of interstitial pulmonary fibrosis; 12 (0.06%) cases of renal insufficiency; and no new cases of viscerotropic leishmaniasis. No clinical indication of a new or unique illness was identified in this self-referred population, and the types of physiologic disease that could result from postulated hazardous wartime exposures were uncommon.

### Introduction

During the 6 years since the end of the Persian Gulf War on February 28, 1991, some veterans of Operations Desert Shield and Desert Storm have presented with a diversity of unexplained somatic symptoms. The most commonly reported symptoms have been fatigue, headache, joint pains, skin rash, shortness of breath, sleep disturbances, difficulty concentrating, and forgetfulness.<sup>1-3</sup> There have been published medical reports of similar symptoms among British and Canadian Gulf War veterans but not among other coalition troops or local inhabitants of Saudi Arabia and Kuwait.<sup>4-6</sup>

To date, no single cause of these somatic symptoms has been demonstrated.<sup>7-11</sup> However, various potential etiologies related to the Gulf War experience have been postulated, including: (1) possible exposure to chemical weapons (CW) and biological weapons (BW);<sup>8-10,12-14</sup> (2) use of pyridostigmine bromide pills for CW protection;<sup>7,8,15</sup> (3) exposure to sand and oil well fire smoke;<sup>8,16</sup> (4) exposure to pesticides, insect repellents, and other chemicals used in military deployments;<sup>9,14,17,18</sup> (5) anthrax and botulinum vaccinations;<sup>7-9</sup> (6) infectious diseases, particularly viscerotropic leishmaniasis;<sup>19</sup> (7) depleted uranium exposure;<sup>7-9</sup> and (8) psychological stress.<sup>11,20-23</sup>

In response to the health concerns of Gulf War veterans, the Department of Defense (DoD) instituted the Comprehensive Clinical Evaluation Program (CCEP) on June 7, 1994. The CCEP was a continuation of prior DoD medical care of Gulf War veterans and screening for new or unusual illnesses but provided a more systematic evaluation strategy. Although not designed as a

\*Assistant Secretary of Defense-Health Affairs, Department of Defense, Defense Drive Pentagon, Washington, DC 20301-1200.

†Team members in alphabetical order are: LTG Ronald R. Blanck, MC USA, DO, The Surgeon General U.S. Army, Falls Church, VA 22041-3258; Lt Col Gary Gackstetter, BSC USAF, DVM MPH PhD, Department of Defense, Office of Assistant Secretary of Defense-Health Affairs (Clinical Services), Defense Drive Pentagon, Washington, DC 20301-1200; LCDR Robert Glaser, MSC USN, MBA, Department of Defense, Office of Assistant Secretary of Defense-Health Affairs (Clinical Services), Defense Drive Pentagon, Washington, DC 20301-1200; CAPT Kenneth C. Hyams, MC USN, MD MPH, U.S. Naval Medical Research Institute, 8901 Wisconsin Avenue, Bethesda, MD 20889-5607; Maj Sheila Kinty, BSC USAF, DVM MPH, Department of Defense, Office of Assistant Secretary of Defense-Health Affairs (Clinical Services), Defense Drive Pentagon, Washington, DC 20301-1200; MAJ Charles Magruder, MC USA, MD MPH, Department of Defense, Office of Assistant Secretary of Defense-Health Affairs (Clinical Services), Defense Drive Pentagon, Washington, DC 20301-1200; John Mazzuchi, PhD, Deputy Assistant Secretary of Defense-Health Affairs, Department of Defense, Office of Assistant Secretary of Defense-Health Affairs (Clinical Services), Defense Drive Pentagon, Washington, DC 20301-1200; COL Francis L. O'Donnell, MC USA, MD MPH, Department of the Army, Office of the Surgeon General, Health Services Directorate, Falls Church, VA 22041-3258; Lt Col Michael D. Parkinson, MC USAF, MD MPH, Office of the Air Force Surgeon General, HQ-AFMOA/SGOP, Bolling Air Force Base, DC 20332-7050; Col Relford E. Patterson, MC USAF, MD MPH, Department of Defense, Office of Assistant Secretary of Defense-Health Affairs (Clinical Services), Defense Drive Pentagon, Washington, DC 20301-1200; and CAPT David H. Trump, MC USN, MD MPH, Department of the Navy, Bureau of Medicine and Surgery, 2300 E Street NW, Washington, DC 20372-5300.

Reprints: Department of Defense, Office of Assistant Secretary of Defense-Health Affairs (Clinical Services), Defense Drive Pentagon, Room 3E-346, Washington, DC 20301-1200.

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research study, the CCEP nevertheless provided valuable clinical information about the health of this population. The following report is an analysis of the findings from comprehensive clinical evaluations of 20,000 Persian Gulf War veterans.

## Methods

### Background

Starting on August 8, 1990, the United States deployed 697,000 troops to the Persian Gulf region.<sup>8</sup> In contrast to previous U.S. conflicts, a larger proportion of troops belonged to the Reserves/National Guard (17%) and were women (7%). Despite the harsh environment and intense preparations for war,<sup>24</sup> morbidity rates among U.S. troops were lower than in previous conflicts,<sup>8,25,26</sup> and mortality rates were very low.<sup>27</sup>

By May 1991, most U.S. troops had returned from the Persian Gulf. Troops who remained on active duty after the war were provided complete health care through the Military Health Services System, which provides medical care for all active duty personnel and other eligible DoD beneficiaries. In addition, the physical condition of active duty U.S. troops is assessed continuously with physical fitness tests every 6 to 12 months, routine dental and gynecological examinations, and a complete medical examination at least every 5 years. Prior to leaving active duty, military personnel are medically screened and undergo a physical examination.

### CCEP Organization

The CCEP was developed to provide a systematic and uniform medical evaluation at 184 military health care facilities located in 39 states, 8 foreign countries, and 2 territories. To institute the CCEP, numerous organizational meetings were held with senior medical officials from all military services; health care officials of the Department of Veterans Affairs (VA) were consulted to ensure that the CCEP and the VA Persian Gulf Health Registry collected comparable data; and four instructional meetings were held with military health care personnel on CCEP procedures and to provide clinical and research information related to Gulf War health questions. A special committee of the Institute of Medicine independently reviewed and monitored the CCEP process, including the design and implementation of the program and interpretation of preliminary findings.<sup>28</sup>

Through vigorous outreach efforts, the 285,000 Persian Gulf War veterans still on active duty when the CCEP was initiated were encouraged to participate if they had any health questions or concerns; a current health problem was not necessary for participation. Also eligible were military retirees, Reserve/National Guard personnel on full-time active duty or on special orders, and civilian DoD employees who were veterans of the Persian Gulf deployment. Family members of qualified Gulf War veterans were eligible for CCEP evaluation but were not included in this analysis.

Eligible veterans could enroll in the CCEP either by calling a toll-free telephone number or by contacting their nearest military medical treatment facility (MTF). Gulf War veterans not eligible for a CCEP examination were referred to the VA Persian Gulf Health Registry for evaluation.

### Clinical Evaluation

The CCEP provided a two-phase clinical evaluation supervised by a board-certified physician in either family practice or

internal medicine.<sup>29</sup> All CCEP participants were provided a Phase I examination, which was conducted at the local MTF and consisted of a thorough clinical examination and a standardized provider-administered questionnaire. All participants were asked about: (1) medical and family histories; (2) symptoms; (3) number of days of work lost due to illness during the 90 days prior to examination; and (4) any self-perceived exposure in the Persian Gulf to among the following: petroleum products, pyridostigmine bromide pills, oil well fire smoke, insect repellents, anthrax and botulinum vaccinations, combat casualties, and actual combat. In addition, the following laboratory tests were performed: a complete blood count, urinalysis, and blood chemistries for electrolytes, glucose, creatinine, blood urea nitrogen, and transaminase levels.

For CCEP participants without current medical problems or who had health problems that could be satisfactorily explained after the Phase I evaluation, no additional evaluation was conducted. Other CCEP participants proceeded to further Phase II examination at one of 14 DoD regional medical centers, if referral consultations and specialized tests were clinically indicated, to diagnose the patient's condition. Phase II participants were administered the Structured Clinical Interview for DSM-III-R<sup>30</sup> and the Clinician Administered PTSD Scale.<sup>31</sup> Additionally, Phase II participants had a purified protein derivative skin test and chest X-ray, and a blood sample was analyzed for the following: sedimentation rate, C-reactive protein, rheumatoid factor, fluorescent antinuclear antibodies, thyroid function, B12 and folate levels, creatine phosphokinase level, HIV-I antibody, hepatitis B surface antigen, and reagin antibody.<sup>28</sup>

At the conclusion of the CCEP evaluation process, examining physicians provided a primary diagnosis and additional secondary diagnoses based on clinical importance. After review by accredited medical record coders, up to seven diagnoses were coded using the International Classification of Diseases-Ninth Revision, Clinical Modification (ICD-9-CM) and entered into the data base.<sup>32</sup> An extensive quality-control process was instituted to ensure uniform evaluation, accurate data collection, and data base validity.<sup>28</sup>

## Results

As of April 1, 1996, a total of 20,000 Persian Gulf War veterans had completed CCEP examinations, with 12% of participants undergoing specialized Phase II evaluations. Compared to all U.S. Gulf War veterans, the CCEP included a higher proportion of women, older veterans, nonwhite racial/ethnic groups, and Army personnel (Table I).

The types of primary and secondary diagnoses among CCEP participants varied widely (Table II). A total of 1,263 separate ICD-9-CM codes were needed to categorize primary diagnoses. Of the 1,263 separate codes used, 41% were applicable to only a single CCEP participant. Relatively frequent primary diagnoses (shared by 25 or more veterans) were distributed among 114 different ICD-9-CM codes.

For broad ICD-9-CM classifications, the three most common primary diagnoses were "diseases of the musculoskeletal system and connective tissue" in 18.6%, "mental disorders" in 18.3%, and "symptoms, signs, and ill-defined conditions" in 17.8% of participants (Table II). Nine percent of participants were found to be "healthy," without a clinically significant new



TABLE I

COMPARISON OF DEMOGRAPHIC CHARACTERISTICS BETWEEN 20,000 CCEP PARTICIPANTS AND ALL U. S. PERSIAN GULF WAR VETERANS

Characteristic	Percent with Characteristic	
	CCEP Participants <sup>a</sup> (n = 20,000)	All Gulf War Veterans (n = 697,000)
Gender		
Male	88	93
Female	12	7
Age in years <sup>b</sup>		
17-25	32	55
26-30	24	20
31-35	23	12
36-65	21	13
Race/ethnicity		
White	57	70
African-American	32	23
Hispanic	5	5
Other	6	2
Rank		
Enlisted	92	90
Officer	8	10
Military branch		
Army	82	50
Navy	4	23
Marines	4	15
Air Force	9	12
Military status		
Active duty	84	83
Reserves/National Guard	8	17
Civilians	8	-

<sup>a</sup>Among CCEP participants, valid data were not available for 3% of rank, 2% of age, and 1% of military branch entries.

<sup>b</sup>Age was calculated as of August 1990. The mean age of CCEP participants was 28 years (median 30 years) compared to a mean age of 27 years (median 25 years) for all Gulf War veterans.

illness. The most common specific diagnoses among patients with a primary diagnosis of a musculoskeletal disease were "pain in joint" (31%), "osteoarthritis and allied disorders" (12%), and "lumbago" and "backache, unspecified" (11%). Among veterans with a primary diagnosis of "mental disorders," 19% had "tension headache," 17% "depressive disorder not elsewhere classified," 15% "prolonged post-traumatic stress disorder" (PTSD), 8% "major depressive disorder, single episode," and 7% "adjustment reaction."

Among the 3,558 participants with a primary diagnosis of "symptoms, signs, and ill-defined conditions," no single ICD-9-CM subcategory predominated (Table III). These 3,558 veterans had a wide variety of symptoms, with fatigue, headache, memory problems, and sleep disturbances being the most frequent presenting complaints (Table IV). Symptoms were reported to have begun more than 6 months after returning from the Persian Gulf by 51% of the 1,026 veterans in this category who indicated a date of onset. Veterans with this primary diagnosis did not have a characteristic sign of disease (including skin rash and fever) or a consistent laboratory abnormality. Also, no distinctive pattern of illness was evident among CCEP participants with this ICD-9-CM code as a secondary diagnosis (Table III).

There were a number of age, gender, and military service trends among broad primary diagnostic classifications. Mental disorders and a diagnosis of "healthy" were more common among younger CCEP participants (Table V). Musculoskeletal conditions were diagnosed more often in older participants (Table V), males (19% compared to 16% among females), and U.S. Army personnel (19% compared to 16% among other services). Women were more likely to be diagnosed with genitourinary problems than men (3% vs. 1%, respectively). Eighty percent of CCEP participants reported not missing any days of work during the 90 days prior to examination.

Among all 20,000 CCEP participants, 74 (0.4%) had a connective tissue disease as either a primary or secondary diagnosis: 33 rheumatoid arthritis, 13 systemic lupus erythematosus, 13 Sjogren's syndrome, 10 mixed or undifferentiated connective tissue disease, 3 systemic sclerosis, and 2 dermatomyositis. Disorders of immunity were diagnosed in 5 participants with selective immunoglobulin A immunodeficiency and one with selective immunoglobulin M immunodeficiency. There were 9 (0.05%) patients who had skin cancers, 22 (0.1%) lymphoma/leukemia, and 30 (0.15%) other types of cancer. Glomerulonephritis was diagnosed in 13 (0.07%) CCEP participants and renal insufficiency in another 12 patients. Fourteen (0.07%) participants had interstitial pulmonary fibrosis.

Polyneuropathy or peripheral neuropathy was diagnosed in 8 and 34 (0.2%) veterans, respectively. A common or distinctive organic pathology was not identified among over 800 veterans with neuromuscular symptoms who had extensive neuropsychological evaluations. These evaluations included nerve conduction studies and electromyography on 300 participants<sup>33</sup> and intensive electrophysiological studies (including single-fiber electromyography and muscle biopsies) on 20 veterans with severe fatigue, weakness, or myalgias.<sup>34</sup>

Common skin infections accounted for 60% of primary infectious disease diagnoses (Table II). Four CCEP participants without characteristic clinical signs of Q fever had minimally elevated serologic titers to *Coxiella burnetii*. There were no confirmed cases of brucellosis, and no new case of viscerotropic leishmaniasis was diagnosed in addition to the 12 previously identified cases.

All elicited exposures were reported frequently, including: exposure to diesel and other fuels (88%); use of pyridostigmine bromide pills (74%); exposure to oil well fire smoke (71%); personal use of insect repellents (66%); anthrax (49%) and botulinum (26%) vaccinations; and observing combat casualties (57%) or actual combat (38%). Independent records were not available to assess self-reported exposures except for botulinum vaccination, which was known to have been given to about 1.1% of troops, mostly in select front-line units. In the broad ICD-9-CM diagnostic categories, there were no major differences in the percentage of CCEP participants reporting various exposures.

## Discussion

This large patient series demonstrated a wide range of well-known illnesses among Persian Gulf War veterans requesting evaluation, with no single illness predominating and no clinical indication of a new or unique syndrome. In addition, the types of medical conditions that would result from postulated Gulf War environmental hazards were diagnosed infrequently, including:

TABLE II  
FREQUENCY OF PRIMARY AND SECONDARY DIAGNOSES BY BROAD ICD-9-CM CATEGORIES AMONG 20,000 CCEP PARTICIPANTS

Category	ICD-9-CM Code	Primary Diagnosis	Secondary Diagnoses
Diseases of the musculoskeletal system and connective tissue	710-739	18.6	29.5
Mental disorders	290-319	18.3	17.9
Symptoms, signs, ill-defined conditions	780-799	17.8	32.6
Diseases of the respiratory system	460-519	6.8	10.8
Diseases of skin and subcutaneous tissue	680-709	6.3	13.7
Diseases of the digestive system	520-579	6.2	14.1
Diseases of nervous system and sense organs	320-389	5.8	12.3
Infectious and parasitic diseases	001-139	2.6	6.4
Diseases of the circulatory system	390-459	2.2	5.9
Endocrine, nutritional, and metabolic diseases, and immunity disorders	240-279	2.1	6.1
Diseases of the genitourinary system	580-629	1.3	4.2
Injury and poisoning	800-999	0.8	2.4
Neoplasms	140-239	0.8	2.1
Diseases of the blood and blood-forming organs	280-289	0.6	2.6
Congenital anomalies; certain conditions originating in the perinatal period	740-779	0.2	0.9

TABLE III  
FREQUENCY OF SPECIFIC DIAGNOSTIC SUBCATEGORIES AMONG CCEP PARTICIPANTS WITH PRIMARY OR SECONDARY DIAGNOSES OF "SYMPTOMS, SIGNS, AND ILL-DEFINED CONDITIONS" (ICD-9-CM CODE 780-799)

Diagnostic Subcategory	ICD-9-CM Code	Percent (number) with Primary Diagnosis (n = 3,558)	Percent (number) with Secondary Diagnosis (n = 9,254) <sup>a</sup>
Malaise and fatigue	780.7/780.71	26.6 (948) <sup>b</sup>	17.9 (1,656)
Sleep disturbances	780.50/52/57	17.6 (627)	14.2 (1,310)
Headache	784.0	14.7 (524)	14.5 (1,342)
Other general symptoms	780.9	10.3 (366)	13.0 (1,200)
Dyspnea and respiratory abnormalities	786.09/786.52	5.7 (204)	7.3 (676)
Symptoms involving skin	782.0/782.1	4.8 (171)	5.3 (487)
Syncope/convulsions/dizziness	780.2/3/4	2.9 (102)	1.9 (175)
Chest pain	786.50/786.59	2.1 (75)	2.0 (189)
Nonspecific reaction to tuberculin test	795.5	1.3 (47)	3.3 (309)
Abdominal pain	789.0	1.3 (48)	1.5 (135)
Cough	786.2	1.1 (38)	0.9 (80)
Other subcategories	-	11.5 (408)	18.3 (1,695)

<sup>a</sup>9,254 secondary diagnoses in the category of "Symptoms, Signs, and Ill-Defined Conditions" among 6,517 individual CCEP participants.

<sup>b</sup>297 with chronic fatigue and 651 with fatigue not specified as chronic.

neurologic disease from possible CW or pesticide exposure, interstitial pulmonary disease from smoke or sand inhalation, renal disease from heavy metal exposure, and immunologic dysfunction from various combinations of exposures.

These findings are consistent with medical surveillance data collected during the Persian Gulf deployment, which indicated that the overall health of U.S. troops was very good;<sup>8,27</sup> serious illness due to pyridostigmine bromide or smoke inhalation was uncommon;<sup>35-37</sup> and clusters of acute disease compatible with either pesticide intoxication or a CW/BW attack were not diagnosed.<sup>8,9,38</sup> Also, the absence of clinical data indicating a new or unique illness is consistent with the findings of three previous review panels that did not identify a distinctive syndrome related to Persian Gulf service.<sup>7,8,11</sup>

A relatively large percentage of CCEP participants did have a psychological condition as either a primary (18%) or secondary (18%) diagnosis. This finding was not unexpected because transient and mild psychological conditions are common in out-patient populations,<sup>39</sup> and studies of military veterans repeatedly have

demonstrated that adjustment reaction and PTSD are prevalent following life-threatening wartime experiences.<sup>40-42</sup> Prior studies additionally have found that the types of physical symptoms, sleep problems, and cognitive difficulties experienced by some Gulf War veterans are frequent manifestations of psychological stress related to war<sup>42-55</sup> and other traumatic events.<sup>56,57</sup>

Also expected among CCEP participants was a large number of musculoskeletal conditions, because this was predominantly an active duty military population that constantly is undergoing physically demanding training.<sup>58</sup> The increased risk of genitourinary problems among female veterans has been found in prior studies of U.S. military populations.<sup>59</sup>

The third common diagnostic category, "symptoms, signs, and ill-defined conditions," did not appear to represent a group of veterans with a distinctive illness. CCEP participants in this diagnostic category varied substantially in clinical presentation, and no characteristic physical sign or laboratory abnormality was identified. The ICD-9-CM category "symptoms, signs, and ill-defined conditions" is not a classification of a mystery ill-

TABLE IV

THE MOST FREQUENT SYMPTOMS AMONG 3,558 CCEP PARTICIPANTS WITH A PRIMARY DIAGNOSIS OF "SYMPTOMS, SIGNS, AND ILL-DEFINED CONDITIONS" (ICD-9-CM CODE 780-799)

Symptoms	Percent Reporting Symptom <sup>a</sup>	
	Chief Complaint	Any Complaint
Fatigue	20.0	59.0
Headache	9.2	44.4
Memory problems	6.3	40.3
Sleep disturbances	4.7	39.8
Skin rash	4.4	30.2
Joint pain	4.2	47.0
Dyspnea	1.8	19.2
Cough	1.3	1.3
Abdominal pain	1.2	16.3
Muscle pain	0.8	21.8
Difficulty concentrating	0.6	31.2
Back pain	0.6	0.6
Dizziness	0.6	0.6
Diarrhea	0.5	18.4
Hair loss	0.1	12.6
Weight loss	0.2	6.9
Bleeding gums	0.1	8.5
Depression	0.3	22.3
Other symptoms	17.3	21.4

<sup>a</sup>Symptoms without a designation of a chief complaint were recorded for 914 (26%) participants.

ness.<sup>32</sup> This diverse category contains more than 160 subclassifications and mainly consists of: ill-defined, often common conditions not coded elsewhere (such as nervousness); isolated laboratory abnormalities (such as "nonspecific reaction to tuberculin test"); and common symptoms without a clear physiologic or psychologic basis. The somatic symptoms specifically coded in this classification—insomnia, fatigue/malaise, headache, dyspnea, palpitations, heartburn—are reported very frequently in general population<sup>60</sup> and outpatient clinic surveys.<sup>61-63</sup> These symptoms, although genuine and sometimes the cause of substantial morbidity, often lack a physical explanation or are related to psychological factors.<sup>63-68</sup>

These clinical findings have to be carefully qualified by the fact that the CCEP was not designed as a research study: participants were self-selected and physically qualified for active military duty several years after the Persian Gulf War, and no control group was available for comparison of illness rates. In

addition, a rare or minimally pathogenic illness could have been missed<sup>28</sup> or not adequately captured in the data base because of diagnostic weaknesses of the ICD-9-CM coding system. Nevertheless, any widespread, serious physiologic disease should have been detected in this very large patient series. It also is unlikely that debilitating disease would remain undetected among active duty troops not participating in the CCEP because of the military's emphasis on readiness and preventive medicine, with regular physical evaluations of troops.

Because the CCEP primarily involved active duty troops, an illness that predominated among Reserve/National Guard personnel or veterans who had been discharged from the military would have been under-represented in the CCEP population. However, no new or unique illness has been identified in the VA Persian Gulf Health Registry, which primarily includes Reserve/National Guard personnel and discharged troops.<sup>9,69</sup> Together, the DoD and VA registry programs have evaluated more than 13% of all U.S. Persian Gulf War veterans for illnesses potentially related to Persian Gulf service.

Although a new or unique illness was not identified, the findings of the CCEP nevertheless provide important clinical information. In the evaluation of Persian Gulf War veterans, physicians will need to be alert for a wide range of illnesses because the diversity of medical and psychological problems that occur in any sizable adult population was found in this cohort. In addition, the findings of the CCEP provide reassurance for Persian Gulf veterans since effective treatments are available for most commonly diagnosed health problems.

Inability in this and prior clinical evaluations to find a characteristic organic sign of a new or unique disease among Persian Gulf veterans will result in research limitations not encountered in studies of well-characterized diseases.<sup>1,3,9,70</sup> Most importantly, a specific case-definition based on criteria that can be objectively measured cannot be developed without a characteristic sign of pathology. Any definition of illness will have to be based on self-reported symptoms, which are subject to confounding and recall bias in a population that has been the focus of widespread publicity about possible harmful exposures and ill health.<sup>71-76</sup> In addition, because of wartime conditions, there are limited records available to quantitate potentially hazardous exposures.<sup>8,9</sup>

Although there are methodological limitations in conducting studies of a possible disease related to the Gulf War, studies of well-characterized disorders can provide vital information about the health of Gulf War veterans. Preliminary research results

TABLE V

AGE TRENDS FOR BROAD PRIMARY ICD-9-CM DIAGNOSTIC CATEGORIES AMONG 20,000 CCEP PARTICIPANTS<sup>a</sup>

Diagnostic Category	ICD-9-CM Code	Percent with Diagnosis by Age Range in Years <sup>b</sup>				
		17-20	21-25	26-30	31-35	>35
Mental disorders (non-PTSD)	290-319	18	16	15	15	14
PTSD	309.81	4	3	3	2	3
Ill-defined conditions	780-799	16	18	18	18	18
Musculoskeletal diseases	710-739	15	17	18	21	20
Other ICD-9-CM categories	-	35	35	36	36	38
"Healthy"	-	13	11	10	8	7

<sup>a</sup>Ages are as of August 1990.

<sup>b</sup>Valid age data were not available for 422 (2.1%) participants.

indicate that this population has normal pulmonary function,<sup>77</sup> has not experienced higher mortality or hospitalization rates from medical causes,<sup>78,79</sup> and has not had higher overall rates of birth defects among its children.<sup>80,81</sup> Several studies indicate that Gulf War veterans have experienced increased levels of psychological stress,<sup>20-23,82-88</sup> with between 5 and 16% of surveyed veterans having symptoms of PTSD.<sup>20,84,86</sup>

Six years after the Persian Gulf War, veterans' health questions remain unresolved because the causes, frequency, and long-term sequelae of nonspecific somatic symptoms are not adequately understood.<sup>62,89-91</sup> Because symptoms of fatigue, headache, joint pain, and insomnia are experienced by all adult populations, it is difficult to determine when these symptoms represent transient conditions or are manifestations of either occult organic or psychological illness.<sup>90-93</sup> Even when somatic symptoms appear to constitute a distinctive syndrome, such as chronic fatigue syndrome and fibromyalgia, specific case definitions have not been developed and etiologic factors remain undetermined despite more than a decade of intensive investigation.<sup>94</sup> Until the nature of nonspecific symptoms and illnesses such as chronic fatigue syndrome is better understood, it will not be possible to thoroughly determine the health of any large population, whether military or civilian.<sup>95</sup>

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*Central Intelligence Agency*



*Department of Defense*

# **Modeling the Chemical Warfare Agent Release at the Khamisiyah Pit**

4 September 1997

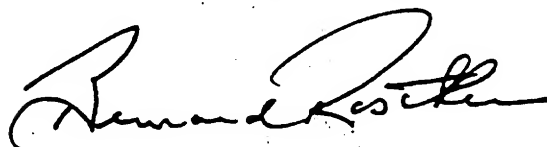


## Introductory Note

As part of CIA's and DoD's continued work to support US Government efforts related to the issue of Gulf war veterans' illnesses, this paper highlights the joint CIA-DoD efforts to model the release of chemical warfare agents from the Khamisiyah pit. This modeling exercise has been a joint effort, with significant coordination among multiple agencies and hundreds of people, with expertise ranging from upper atmospheric conditions to soil characteristics. Since 21 July 1997 we have provided many briefings to Secretary Cohen and the Joint Chiefs, DCI Tenet, Senator Rudman, the staff of the National Security Council, the Presidential Advisory Committee, Congressional staffers, representatives from veterans' organizations, and the media. This report is our effort to make this information as widely available as possible.



Robert D Walpole  
Special Assistant to the Director of Central Intelligence  
for Persian Gulf War Illnesses Issues



Bernard Rostker  
Special Assistant to the Deputy Secretary of Defense for  
Gulf War Illnesses

**Figure 1**  
**Khamisiyah Storage Site, Iraq**



## Contents

### Modeling the Chemical Warfare Agent Release at the Khamisiyah Pit

#### Background

In September 1995, CIA analysts identified Khamisiyah as a key site that needed to be investigated because of its proximity to Coalition forces and the ambiguities surrounding the disposition of chemical weapons at the site; CIA informed DoD of its findings. On 10 March 1996, a CIA analyst heard a tape of a radio show in which a veteran described bunker demolition at a facility the analyst immediately recognized as Khamisiyah. He informed DoD the next morning and the PAC later that week. This identification prompted further investigation of the site, including discussions with UNSCOM.

In May 1996, Iraq told UNSCOM inspectors that US troops had destroyed chemical weapons in the pit near the Khamisiyah depot. After receiving details from UNSCOM in June, DoD was able to interview soldiers who confirmed the demolition of 122-mm rockets in the pit. We discussed this at the PAC meeting in Chicago in July 1996.

The PAC and NSC staff directed CIA to have one of its contractors model multiple chemical warfare agent releases. *Modeling* is the science and art of using interconnected mathematical equations to predict the activities of an actual event, in this case the direction and extent of the chemical warfare agent plume. Modeling is necessary because we do not know what the plume actually did. In such cases, modeling uses obtainable data—the number of rockets, weather, and so forth—to develop a best estimate of the extent of potential exposure. Our modeling efforts apply state-of-the-art atmospheric models, which consist of global-scale meteorological modeling of observational data; detailed regional meteorological modeling using regional and global-scale observations and global-scale model calculations; and transport and diffusion models simulating the contaminant transport based on the flow and turbulence fields generated by the regional model.

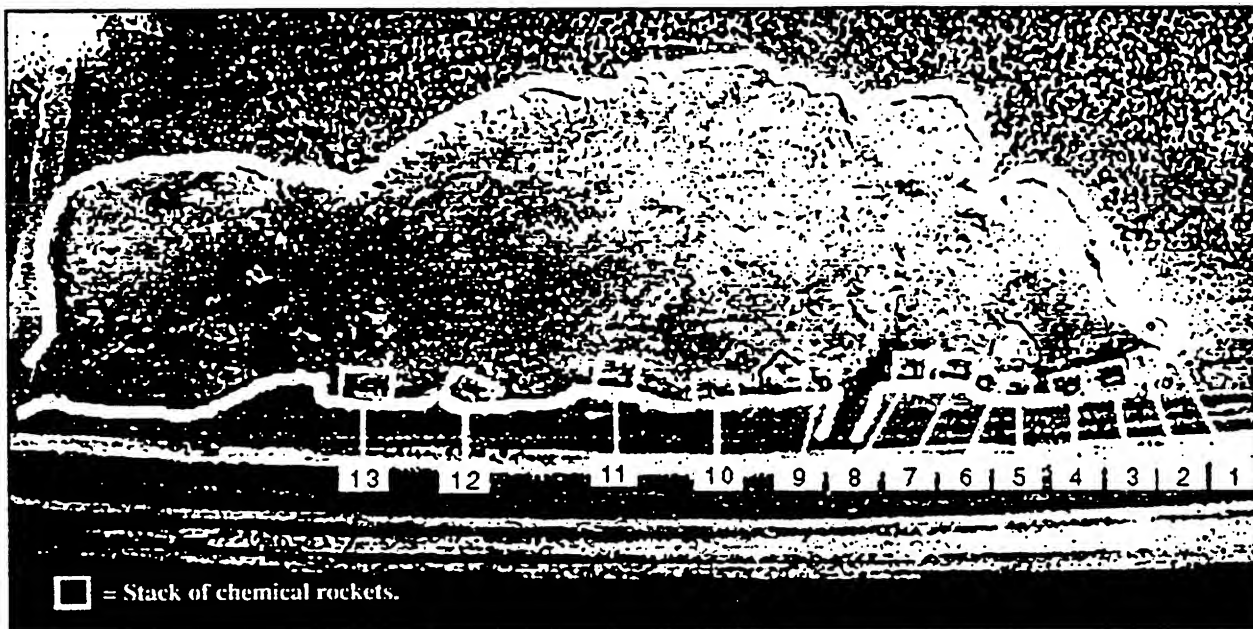
We quickly realized that modeling the pit presented far greater challenges than modeling Bunker 73 at Khamisiyah and other releases. We were able to model the events at Al Muthanna, Muhammidiyat, and Bunker 73 largely because we had test data from the 1960s indicating how chemical warfare agents react and release when structures in which they were stored were bombed or detonated. However, when we began to model the pit, we had significant uncertainties regarding how rockets with chemical warheads would be affected by open-pit demolition. It became clear by October that, without testing the demolition in the open, these uncertainties would remain.

We informed the PAC in November of last year and March of this year, that the proximity of US troops and the prevailing winds at the time of the event identified the associated chemical warfare agent release as a priority for further study. However, we also noted that we had significant uncertainties in attempting to characterize the event:

- Very limited and often contradictory information from two soldiers.
- Questions on the date(s) of demolition.
- Uncertainties on the number of rockets, agent purity, and amount of agent aerosolized.
- Uncertainty on agent reaction in an open-pit demolition.
- Limited weather data.
- No single model that runs weather and chemical warfare agent data simultaneously.

These uncertainties required a more intense study to determine the potential hazard area. DoD and CIA undertook an extensive effort to characterize as

**Figure 3**  
**Predemolition Photo of Pit Area Near Khamisiyah**



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indicated that in the first stack he set as many as four charges on each rocket—two on both the warhead and booster. That would have required more charges than were available. Because different soldiers used different methods on different stacks, we must assess that the placement of charges varied by stack.

#### **IDA Panel Provided Meteorological Expertise**

The uncertainties mentioned earlier brought modeling efforts to a halt. Former Deputy Secretary of Defense John White and former Director of Central Intelligence John Deutch asked the Institute for Defense Analysis to host a panel of experts to review the previous modeling attempts at the pit and to make recommendations for proceeding. The IDA panel consisted mostly of meteorological experts. Their expertise served as the basis for important recommendations regarding the meteorological aspects of modeling the pit release.

#### **Refining the Modeling Input Parameters**

##### **Number of Rockets in Pit Exceed Iraqi Declarations**

Although the Iraqis declared to UNSCOM in May 1996 that 1,100 rockets were in the pit, we assess that the number was somewhat higher. The Iraqis indicated that 1,100 of the 2,160 rockets declared to have been at Khamisiyah were moved from Bunker 73 to the pit. Recent Iraqi press reports suggest that the pit contained roughly one-half of the 2,160 rockets moved to Khamisiyah (or about 1,080 rockets). However, based on the size of the crates, the varying heights of the stacks, and soldier testimonies, our best estimate of the number of rockets in the pit is 1,250. We derived an upper bound of 1,400 rockets by including uncertainty in stack width, using tight edge-to-edge packing, and assuming all stacks were the same height as the tallest of the 13.

accurately as possible the demolition activities at the pit as well as the subsequent dispersion of the agent. This involved the aggressive analysis of any thread of information related to the noted uncertainties, as well as the formation and coordination of a technical working group consisting of modelers from the participating agencies in order to identify the extent of the release.

## **Reducing General Uncertainties**

### **Interviews With Veterans Invaluable**

Working with DoD's Investigation Analysis Division, we have been able to locate and jointly interview five soldiers involved in or claiming to have been involved in the pit demolition—three more than in October of last year. We believe this constitutes at least half of those involved at the time. The participants provided key information addressing our uncertainties, including the numbers of events, munitions, and charges, as well as the placement of the charges. This information was critical to our Dugway tests and to the completion of a meaningful model.

### **Eliminating Uncertainty Surrounding the Date**

The soldiers indicated that the pit demolition occurred on 10 March 1991, coincident with the documented demolition of about 60 bunkers and 40 warehouse buildings nearby. A 10 March demolition is also supported by the fact that some of the soldiers involved in the demolition left for Saudi Arabia on 10 March, as documented by military records. According to four of the five soldiers, the event started at 4:15 p.m. local time (1315Z); one soldier remembers the pit demolition starting a few minutes after the bunker demolition. On the basis of these interviews, we assess that 13 stacks were detonated simultaneously in two groups of stacks fuzed separately. (See figure 3 for the layout of the stacks.)

### **Troops Working With Limited Amount of Explosives**

On the basis of these interviews, we assess the soldiers used about four boxes of US C-4 explosives, which would have provided 120 charges. All soldiers indicated that there were insufficient numbers of

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### ***Why the Limited Explosives Resources?***

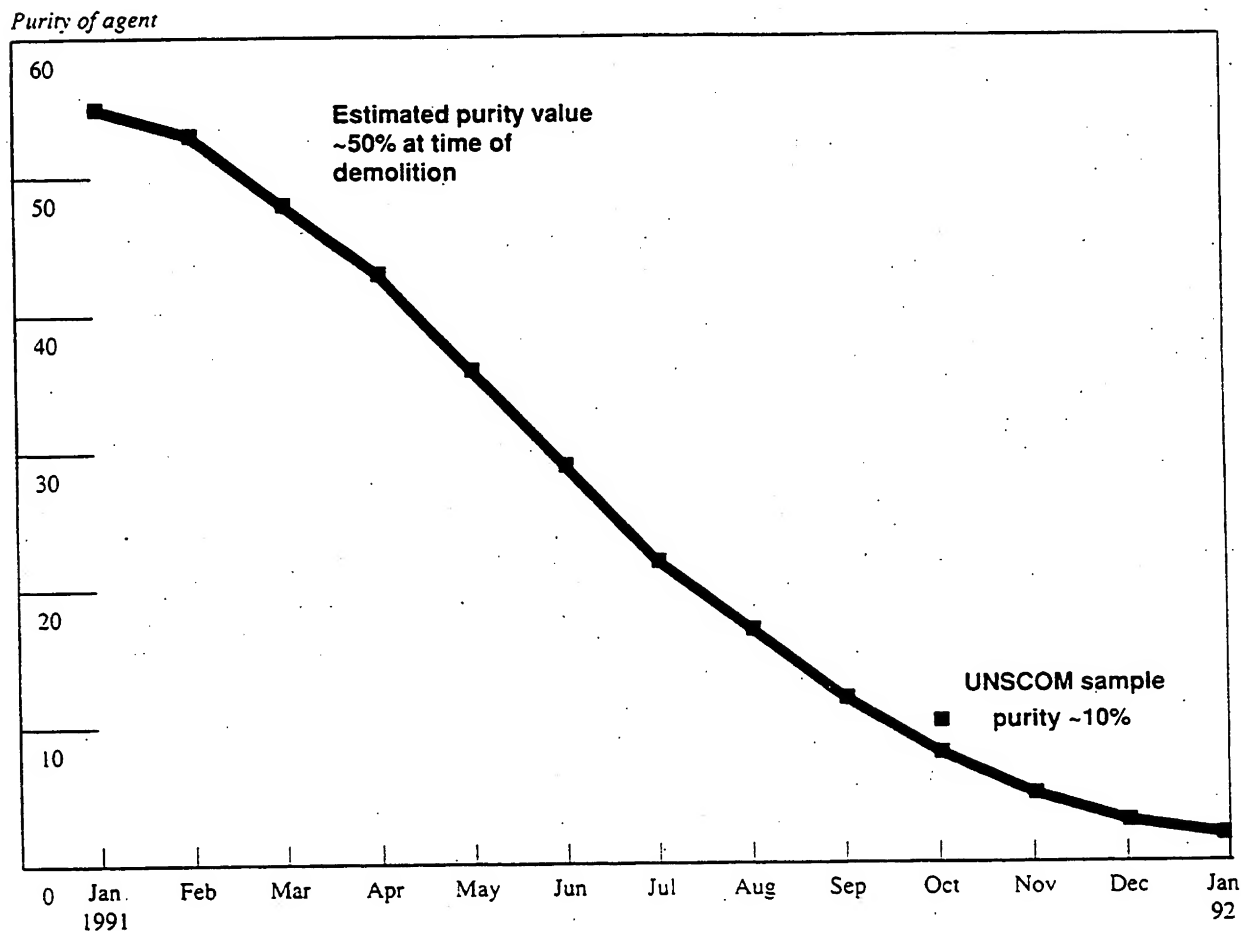
*The operational planning for the demolition of the main part of the Khamisiyah depot—60 bunkers and 40 warehouses—was done in accordance with standard explosive ordinance disposal (EOD) practices for the magnitude of the demolition. However, the rockets in the pit were discovered after most of the explosives had been allocated for that main demolition. Hence, the Army personnel had to collect ad hoc resources to conduct the pit demolition. Also, given the deadlines for departure, the pit demolition could not be delayed to allow additional explosives to be delivered. In addition, many EOD personnel were scheduled to be reassigned to other important facilities. At the time, the military personnel at Khamisiyah had not received warnings about chemical weapons there, and thought they were destroying high-explosive rockets. Such a demolition would not have been as high a priority as the much larger amount of weapons in the main part of the facility.*

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charges to completely destroy the rockets, even with the anticipated sympathetic detonation of what they thought were high-explosive warheads. They had to use Czech detonation cord to complete the demolition.

The interviews indicate that the thoroughness of the demolition varied by stack. All the soldiers indicated that the ends of crates were broken out and the charges were placed inside (although it is possible that some charges were simply affixed to the crate exterior for the sake of expediency). They also indicated that the orientation of the rockets varied—some pointing toward the embankment, some away. The soldiers' recollections from this point vary, however. One stated that charges were placed on the side opposite the embankment and only on warheads. Another contradicted that assertion, indicating that the charges were placed at both ends of the crate with some on warheads and some on rocket sections. A third soldier

**Figure 5**  
**Degradation of Combined G-Agent**



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are similar, we assess that the ratio when the munitions were blown up in March 1991 was the same as that sampled in October 1991—3:1. Assuming a conservative, exponential degradation of the sarin/cyclosarin, the purity on the date of demolition two months after production can be calculated to be about 50 percent.

#### **Establishing Initial Wind Direction**

The Khamisiyah plume analysis is a retrospective analysis; hence, the opportunity for direct comparison

with weather observations is limited. Several sources of imagery data, however, are available for the period 10-11 March 1991 which may provide qualitative comparison. During the May 1996 inspection of Khamisiyah, UNSCOM took GPS coordinates in the pit and recorded the location as 30° 44' 32" N 46° 25' 52" E. An intense effort to find weather data for the area has netted good information on wind direction at the time of the explosion in March 1991. These include photography of the soot patterns created by



### Demolition Affected Less Than 40 Percent of the Rockets

Sometime during the year following the demolition, the Iraqis bulldozed and handcarried the remnants of the 13 stacks into seven piles. In the process, they likely damaged more of the rockets and buried others. UNSCOM inspectors recovered a total of 782 undamaged rockets: 463 taken from the surface, including 389 that were filled, 36 that were partially filled (we attributed this partial leakage to the Iraqis in our modeling), and 38 that were unfilled; and 319 unearthed from the pit, all of which were filled. UNSCOM ensured that all were subsequently destroyed, either in place at Khamisiyah or at Al Muthanna where they were later moved.

Accordingly, our best estimate of the number of rockets damaged during the demolition is 500. This was derived by subtracting from 1,250 a total of 744 (782 found undamaged minus 38 of which were unfilled, conservatively assuming they released agent during the demolition). The result, 506, was rounded to 500. This estimate is primarily intended for illustrative purposes: the modeling effort used percentages and amounts of total agent in the pit—7,875 kg or 1,882 gallons. This means that 744 rockets' worth of agent—60 percent or 1,129 gallons—did not disperse during the demolition in March 1991 and was subsequently destroyed by UNSCOM.

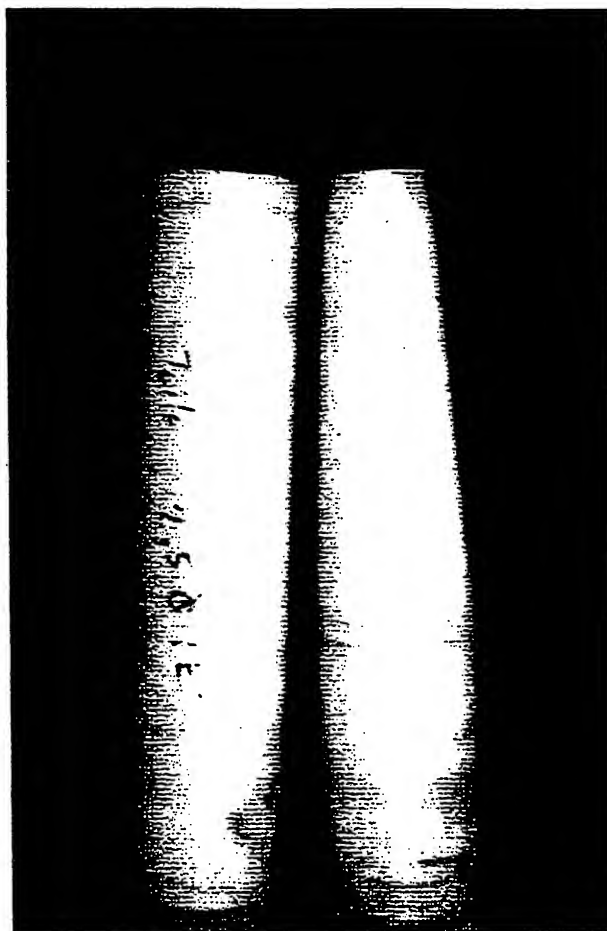
### Amount of Agent per Rocket

Previous modeling efforts—completed for Bunker 73 and halted for the pit—estimated that each rocket contained 8 kg of chemical warfare agent. This was a conservative estimate based on subtracting the mass of an empty warhead from that of a full one (19 kg minus 11 kg). However, in preparation for ground demolition testing in May 1997, we analyzed Iraqi plastic inserts (figure 4) and found that they contained only 6.3 kg of agent. Our earlier estimate had included the mass of the 1.7-kg inserts.

### Agent Purity

Our best estimate of the agent purity at the time of demolition is slightly less than 50 percent (see figure 5). Iraqi production records obtained by UNSCOM indicated that the sarin/cyclosarin (GB/GF) nerve agent produced and transported to Khamisiyah in

Figure 4  
SAKR-18 Inserts Obtained  
by UNSCOM

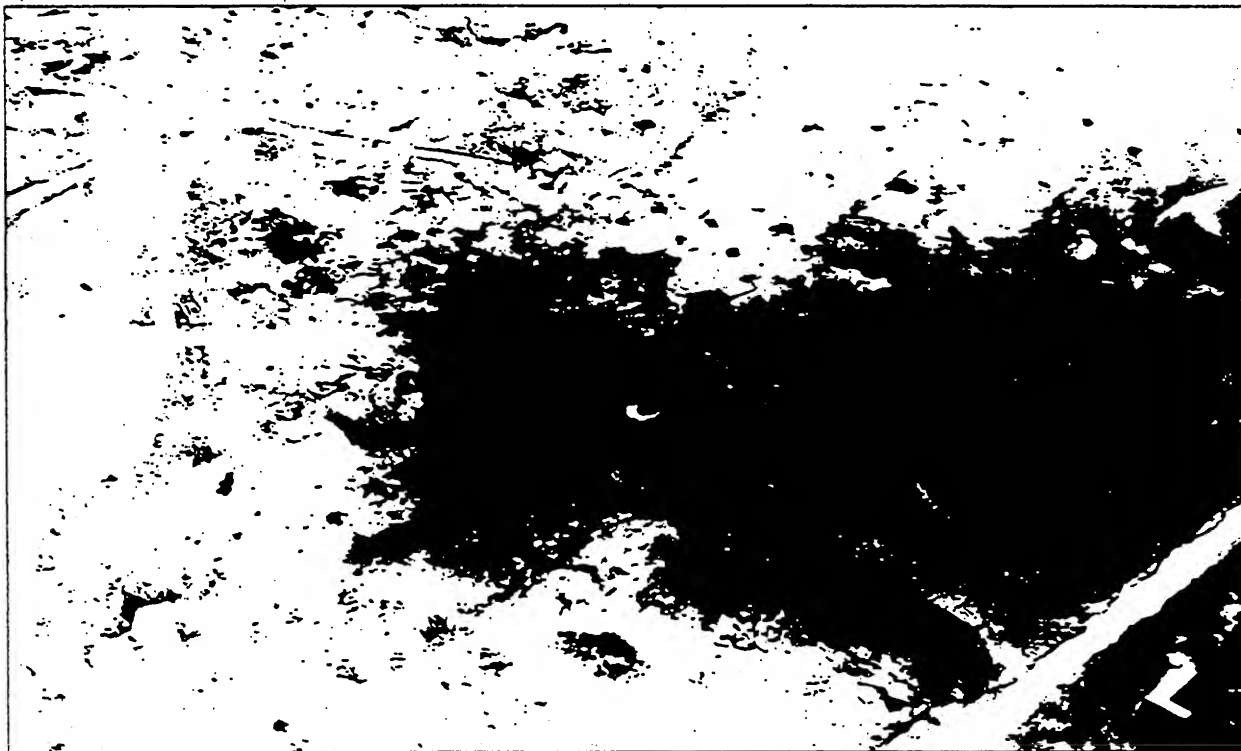


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early January 1991 was about 55 percent pure. (The tests documented in the records showed purity levels ranging from 45 to 70 percent, with 55 percent being the average from 1990 test dates.) The agent subsequently degraded to 10-percent purity by the time laboratory analysis had been completed on samples taken by UNSCOM from one of the rockets in October. On the basis of the sample purity and indications that the degradation rate for sarin and cyclosarin

**Figure 7**  
**Helicopter Photo of Bunker 16—September 1992**



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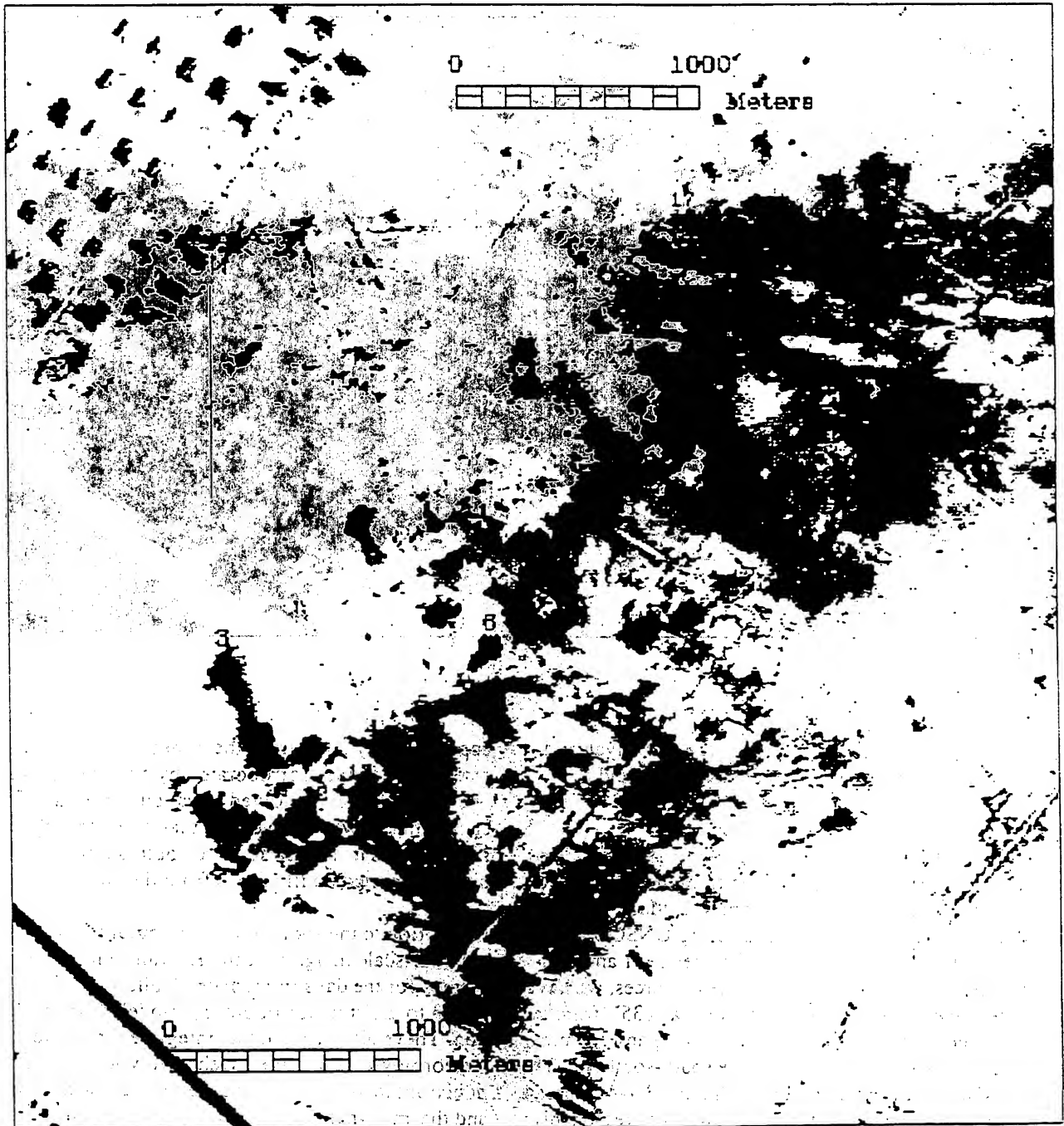
the 10 March bunker explosions at Khamisiyah and regional-scale imagery of the Kuwaiti oilfield fire plumes.

Using SPOT photography of 27 April 1991 (figure 6), analysts derived wind direction from distinct trails of windblown soot and ejecta from individual bunkers and corroborated their findings using UNSCOM helicopter color photos from October 1991 and September 1992 (figure 7). Using these sources, we have determined that the wind direction was 335° (from the north-northwest), thus initially blowing any chemical agent released from the pit to the south-southeast. The consistency of the azimuths within the 3.4-km spread of the bunker area destroyed allows us to reasonably translate the wind direction information to the pit area

approximately 2 km from the bunkers. This wind direction is further corroborated by statements from one of the soldiers involved in the pit demolition, indicating that he was in a vehicle that drove through the smoke cloud in an area south to south-southeast of the pit. He reported no ill effects from the smoke.

In addition to the soot pattern photography, we used regional-scale imagery of the Kuwaiti oilfield fire plumes for the days immediately following the detonation to assist in corroborating modeled wind direction. These also provided an integrated measure of meteorological quantities such as low-level wind direction, low-level wind speed, vertical wind shear, and thermodynamic stability.

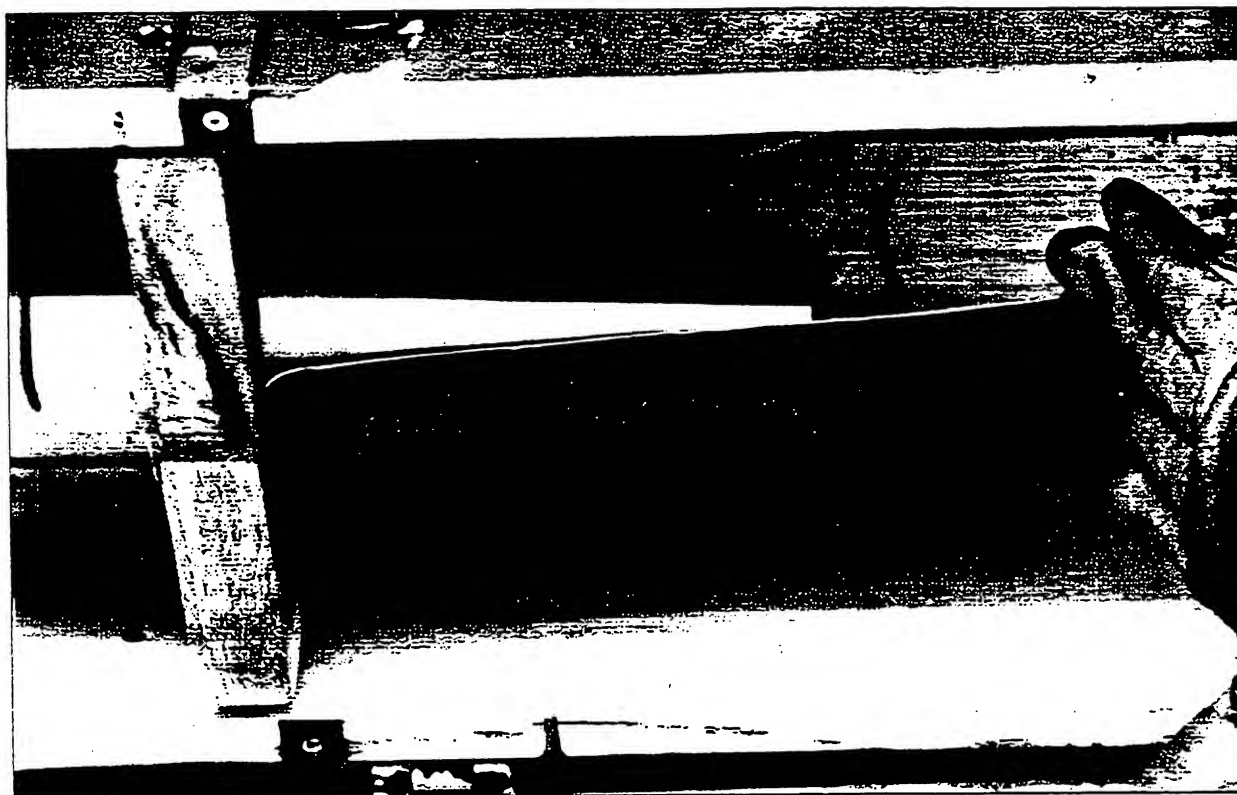
Figure 6  
Khamisiyah Bunker Soot Patterns—10 March 1991



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**Figure 9**  
**Placement of C-4 Charge**  
**on Warhead, Dugway**



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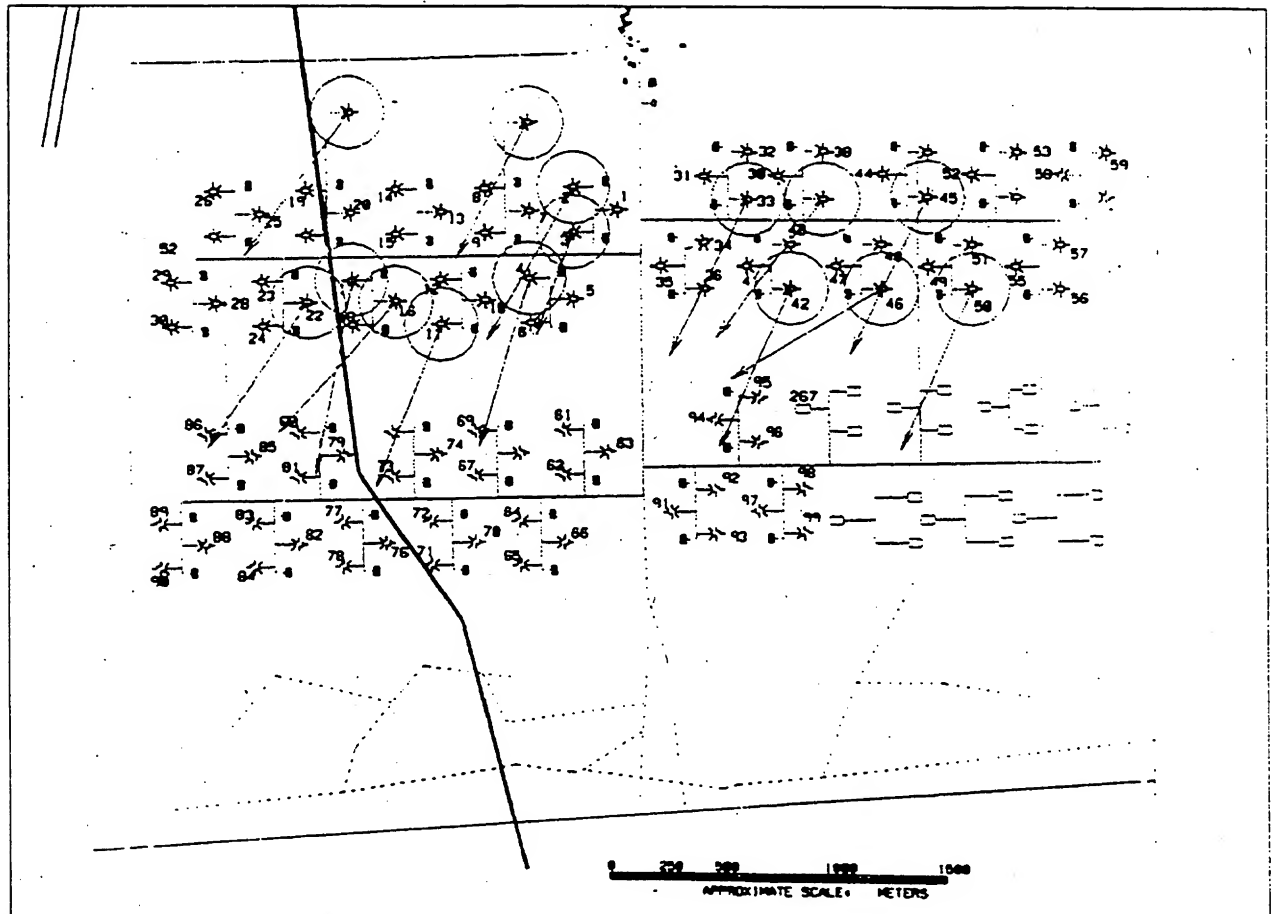
Grounds, which gave us a much better understanding of the events at Khamisiyah. DoD provided complete logistic and administrative support for the tests.

The testing involved a series of detonations of individual rockets and some in stacks, with high-explosive charges placed the way soldiers say they placed them in March 1991. This was done to resolve questions like: how did the rockets break? what happened to the agent? were there sympathetic detonations? how much agent might have been released? We could not replicate the entire demolition of hundreds of rockets, but we did gain information critical to our modeling efforts.

First, we took special care in replicating the rockets in the pit, including:

- Using 32 rocket motors identical to those detonated in the pit.
- Manufacturing warheads based on detailed design parameters provided by UNSCOM, including precise wall thicknesses, materials, and type of burster tube explosive.
- Building crates based on precise measurements and UNSCOM photographs.

**Figure 8**  
**Khamisiyah Bunker Soot Azimuths**



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## Dugway and Edgewood Testing

### Ground Testing Essential

During last year's modeling efforts, we noted that without ground testing we could not estimate with any degree of certainty the amount of agent released at Khamisiyah or the rate of release. In the 1970s, the US conducted additional testing on US chemical rockets to characterize the impact of terrorist actions. Unfortunately, the US tests did not measure the amount of airborne agent downwind and did not help quantify

probable release parameters. Thus modelers of the pit demolition were unable to assess whether the agent would be released nearly instantaneously or over a period of days. The later scenario obviously was more dependent on weather conditions.

To resolve these uncertainties, CIA and DoD agreed in April 1997 on the need to perform ground testing before a meaningful computer simulation could be completed. We cooperated to design and implement a series of tests in May 1997 at the Dugway Proving

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## Flyouts

*Several soldiers reported seeing up to a dozen rockets flying from the pit area during the demolition. We believe the number of flyouts was low because most of the charges were placed on the warhead area of the rocket, which would not have ignited the motor. Charges placed on the motor end probably would have caused most of the rockets to fly into the embankment. Those rockets that did fly out of the pit area generally would not have the proper stability, optimum launch angle, or even the normal thrust in some cases to go any appreciable distance.*

*We modeled several rocket flyout possibilities. Although the maximum range of the rocket is 18 km, we don't believe any flew that far. Pictures after the demolition show most of the rockets have a band or clamp on the tail stabilizing fins—rockets launched without fin deployment probably would fly only 2 to 4 km. With the fins deployed, the rockets could reach 5 to 15 km.*

*The plume from the amount of agent released from the rocket flyouts should have been small. A drop test at Dugway Proving Grounds showed that the rocket would bury itself about 30 feet below ground level without spilling any agent. We believe that the longer range flyouts would have buried themselves also. If one of the rockets did spill the agent, the general population limit would be perhaps 50 m wide and extend downwind about 1 km. We have not shown any flyouts in our plumes because:*

- *US tests on 155-mm rockets showed that most flyouts went only 200 meters and that the maximum range was 2 km—within our estimated plumes.*
  - *We do not believe any actually burst.*
  - *We would not be able to determine where they actually impacted.*
- 

of a model to determine the effect of various placements of charges and orientations of rockets:

- Charges were placed on the ends of rockets opposite the embankment. (As cited in interviews with US soldiers.)
- Charges broke adjacent warheads but not warheads at the other end. (Dugway field testing)
- Evaporation in accordance with Dugway laboratory testing of a 3:1 mixture of sarin/cyclosarin agent at a temperature of 14 degrees C.
- Number of rocket flyouts is low (fewer than 12) with probability of leakage from the rockets minimal. (Soldier interviews and Dugway testing.)

We feel confident that the model paradigm is consistent with UNSCOM information, soldier photos, and conservative assumptions. For example, the proportion of rockets whose agent was not affected during our ground testing (56 percent) closely matched the 708 filled rockets UNSCOM found after the demolition (56 percent). Also, examination of the three known postdemolition pit photos of the rockets show very little damage with only 4 out of 36 rockets (11 percent) showing obvious damage (figures 12 and 13).

### Evaporation Testing Recognized as Critical

The large percentage of agent leaking into the soil and wood increased the importance of additional work conducted at Dugway and Edgewood laboratories. The tests were initially planned at Dugway and Edgewood to be performed on soil but, on the basis of the Dugway ground testing results, were expanded to include wood. These tests began by spilling the sarin and cyclosarin mixture onto wood and soil, respectively, and then measuring the rate at which the agent evaporated. The tests also were designed to closely replicate conditions in the pit, including:

- Sarin and cyclosarin—not simulants—were used in a 3:1 ratio.



**Figure 10**  
**Representation of Charges**



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- Choosing a chemical agent simulant, triethyl phosphate, that closely simulates the volatility of cyclosarin and is often used as a simulant for sarin.
- Stacking the rockets as described by soldiers involved in the pit demolition.

We performed six tests at Dugway using the 32 available rockets. We began with four tests on single rockets in preparation for tests involving nine and 19 rockets. We included a few dummy warheads to increase the size of the stacks. Finally, one of the unbroken rockets from the multiple tests was dropped from an aircraft to simulate a flyout.

#### **Flyouts**

The results were very revealing. The only warheads that burst and aerosolized agent were those that had charges placed just beyond the nose of the warhead. Only the warheads immediately adjacent to the charges leaked agent. Even the rocket dropped to

simulate a flyout did not disperse any simulant; it buried itself over 30 feet below the surface. The pie chart in figure 11 shows the distribution of agent from these tests among aerosolized vapor and droplets, spill into soil and wood, burning, and unaffected. Only about 32 percent of the agent was released, mostly leaking into the soil and wood. A total of 18 percent became part of the plume—two percent through aerosolization and 16 percent through evaporation (5.75 percent from soil and 10.4 percent from wood).

The Dugway testing provided a physical basis for estimating the effect of a charge on the surrounding rockets. We used pressure sensors to refine our gas dynamics models to approximate the threshold forces required to break a warhead. Gas dynamics modeling of the detonations and resultant pressure waves further bolstered our confidence that the results of the Dugway testing were realistic. This allowed development

**Figure 12**  
**Postdemolition Photo of**  
**Stack 9 in Pit at Khamisiyah**



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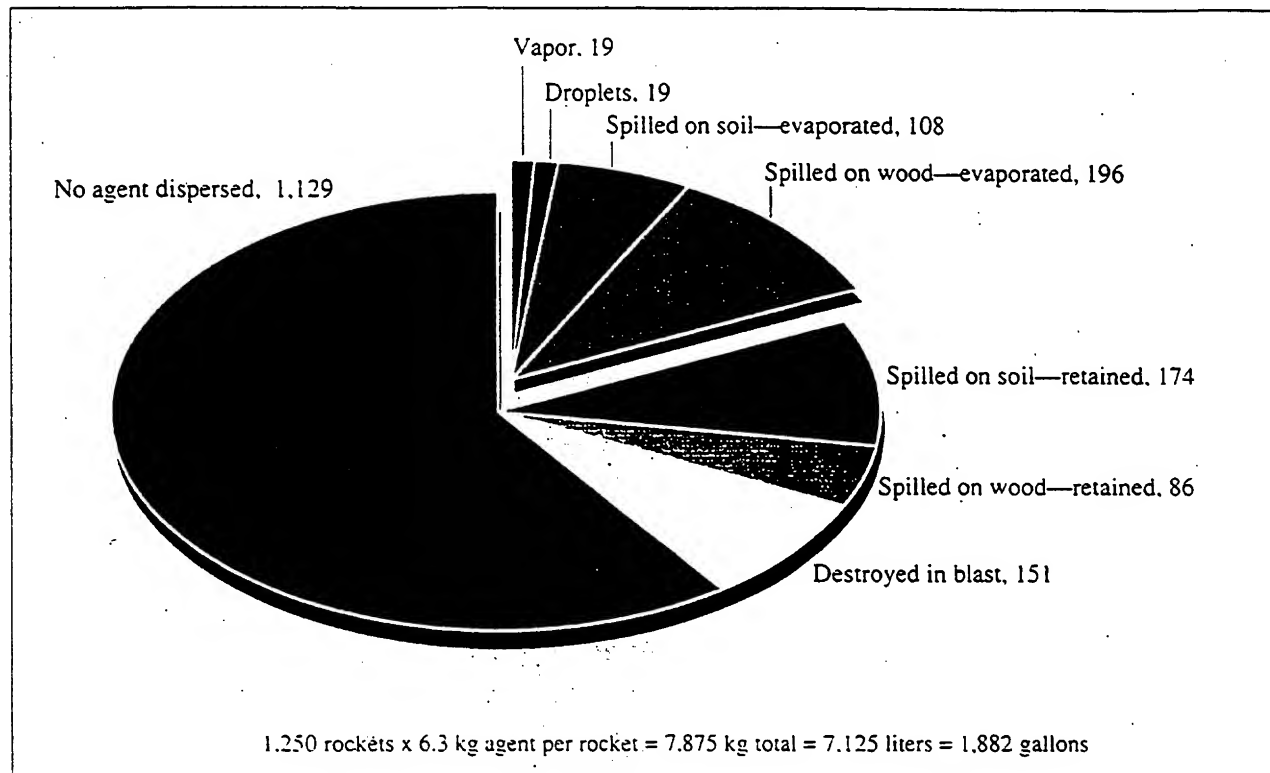
various models. To address these uncertainties, the DoD/CIA modeling team used a variety of models in several different combinations as recommended by the Institute for Defense Analysis review panel.

The models chosen are highly versatile advanced atmospheric and transport and diffusion modeling systems. Because all models have relative strengths and weaknesses, we used multiple models to reconstruct the event. This strategy also helped identify any model-induced (as opposed to data-induced) uncertainties. Figure 15 depicts the interrelationship of the models in this effort.

#### **Meteorological Reconstruction**

Determining accurate regional-scale meteorological fields for several days is crucial for modeling the transport of nerve agent in the atmosphere. Because a comprehensive set of local and regional observed weather conditions was not available, the IDA panel recommended using several different wind field modeling techniques to assess the sensitivity and robustness of dispersion results. Accordingly, the DoD/CIA team attempted to reconstruct the weather conditions on 10 to 13 March 1991 to the highest fidelity possible. This reconstruction consisted of regional

**Figure 11**  
**Agent Disposition in Gallons**



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- Soil, including some from Iraq, which was assessed to be similar to pit sand, was obtained for the tests. We tested pine, a common wood used for 122-mm rocket boxes.
- Tests simulated the wind speeds most likely present during the pit demolitions. Different temperature ranges were used to cover the range of daytime and nighttime temperatures in the pit.

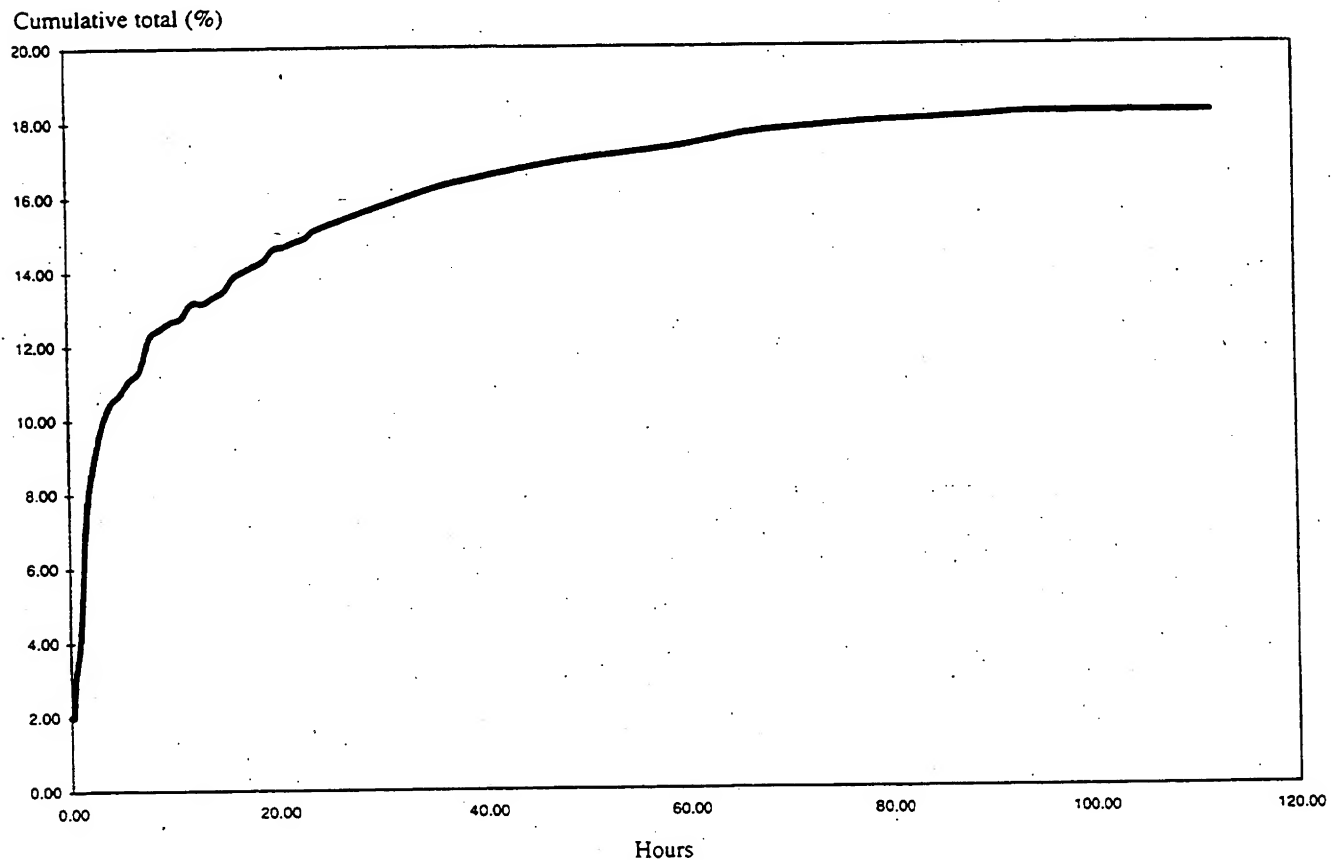
The plot in figure 14 presents the results of the Dugway laboratory tests, which provided the more conservative results of the two laboratories. Of particular interest, most of the chemical warfare agent evaporated during the first 10 hours. Thereafter, with a significantly decreased surface area from spillage, the

release was slow, and significant portions of the agent stayed in the soil and wood. In addition, tests of the soil at Edgewood indicated that about one-eighth of the agent degraded in the soil in the first 21 hours.

#### Using an "Ensemble" of Models

While multiple efforts already discussed significantly reduced uncertainties in the input parameters for modeling the chemical warfare agent release, uncertainties in the results of long-range transport and diffusion also arose because of the relatively limited meteorological data in the region, the complexity of the modeled phenomena, and limitations and differences in the

**Figure 14**  
**Total Sarin and Cyclosarin**



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predict the wind speeds and directions at any point in the region. (Local effects include such influences as moisture variations due to marshes, local terrain, and the Persian Gulf sea breeze.) All models used by the DoD/CIA team include planetary boundary layer dynamics because they dominate the transport and diffusion of the agent cloud.

Several variations using the meteorological models were conducted to investigate the relative contributions of observational data and global-scale predictions to the dispersion of the agent from the pit. For example, NRL performed multiple variations of the

meteorology with the NOGAPS/COAMPS pairing. These included a "baseline" run, where the NOGAPS global input to COAMPS was held constant; "data denial" runs, where meteorological observation data were ignored; and a "random perturbation" run, where generated local "observations" were randomly changed to represent observational error. In order to examine other model-induced effects, both OMEGA and MM5 were initialized with different global-scale drivers; OMEGA driven by GDAS (in addition to NOGAPS) and MM5 driven by GDAS and ECMWF.

**Figure 13**  
**Debris From 9-Rocket Demolition at Dugway**



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(mesoscale) weather model predictions with data assimilation of all available observations, including those from global-scale (synoptic) sources. The meteorological reconstruction drew upon the following:

- Operational global observational data (although relatively sparse in the Persian Gulf region) available during March 1991.
- Additional observational data from the Persian Gulf region not operationally available in March 1991. These data include delayed Saudi surface and rawinsonde (formerly known as *radiosonde*) data, declassified surface data collected by USAF and Special Forces in the Khamisiyah region, declassified Navy Ship Data, and satellite data.
- Archived global forecast fields generated by GDAS during March 1991 using operational data, or global reanalysis with a current model (NOGAPS) assimilating operational data mentioned in the first two bullets. These analyses combined observational data with results of global forecast models at six-hour intervals to predict wind fields at local and regional levels.
- Local and regional predictions, using three independent models: COAMPS, OMEGA, and MM5. These models use large-scale observations and calculations from the global GDAS and NOGAPS models to initialize and set boundary conditions. Using these initial constraints and local effects, these models

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## Model Selection

*We chose these models on the basis of several criteria. First, the level of fidelity had to be adequate to resolve important features of the event. For example, the transport and diffusion models had to be able to accept updates from weather models at intervals on the order of every hour. Also, operational regional weather models must handle planetary boundary layer transport and resolve the effects with sufficient fidelity to meet the requirements for the Khamisiyah event. Secondly, the models must have been subjected to various stages of validation against known analytic solutions, well-studied idealized atmospheric flows, and observational data. Where appropriate, nonlinear simulations from the models should have been compared with results from other models accepted in the meteorological community. Thirdly, the transport and diffusion models must have demonstrated previous application to chemical warfare agent dispersion problems and include a satisfactory agent database. Finally, the models must be off-the-shelf, configured to respond to the rapid timetable and data needs imposed by the humanitarian urgency of this project.*

*Establishing linkages between weather and transport models is critical and was emphasized by the IDA panel. Attempts by CIA's contractor, SAIC, in 1996 to model the pit used the analytical linkage between the OMEGA weather model and the VLSTRACK transport and diffusion model to drive the NUSSE4 transport and diffusion model. NUSSE4 had an established*

*but unique ability to handle multiple agents, which was the case with the Khamisiyah rockets. Efforts to expand the analysis of the pit in 1997 focused on enhancing other linkages. The Defense Special Weapons Agency (DSWA) linked the OMEGA and COAMPS mesoscale models and SCIPUFF—a DSWA transport and diffusion model. SCIPUFF has been demonstrated and validated in a test series at the White Sands Missile Range. The Naval Research Laboratory (NRL) teamed with the Naval Surface Weapons Center (NSWC) to link the COAMPS model with the VLSTRACK dispersion model, which is widely used in the Navy and elsewhere in the military for tactical analyses and can accommodate varying meteorology. VLSTRACK was validated against sets of field trial data from at least 60 reports on chemical and biological agent and simulation releases. Recently it has also been the subject of an independent review by the National Oceanographic and Atmospheric Agency (NOAA).*

*In response to the IDA Panel's suggestion that an established non-DoD local and regional weather model be included in the effort to provide comparative results, NRL was also able to secure 48 hours of meteorological reconstruction generated by the MM5 model from the National Center for Atmospheric Research (NCAR).*

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## Modeling the Transport and Diffusion of Chemical Warfare Agent

All transport and diffusion models used in this effort (SCIPUFF, VLSTRACK, and NUSSE4) characterized the detonation using 13 stacks distributed over a 300-meter-long line. For modeling purposes, the masses associated with each stack were considered to be spaced at even intervals. The initial release height was assessed to have been about one meter, or about half-way up the stacks. The release from all stacks was judged to have occurred simultaneously. Each of the 13 stack locations resulted in an initial 6-kg vapor puff

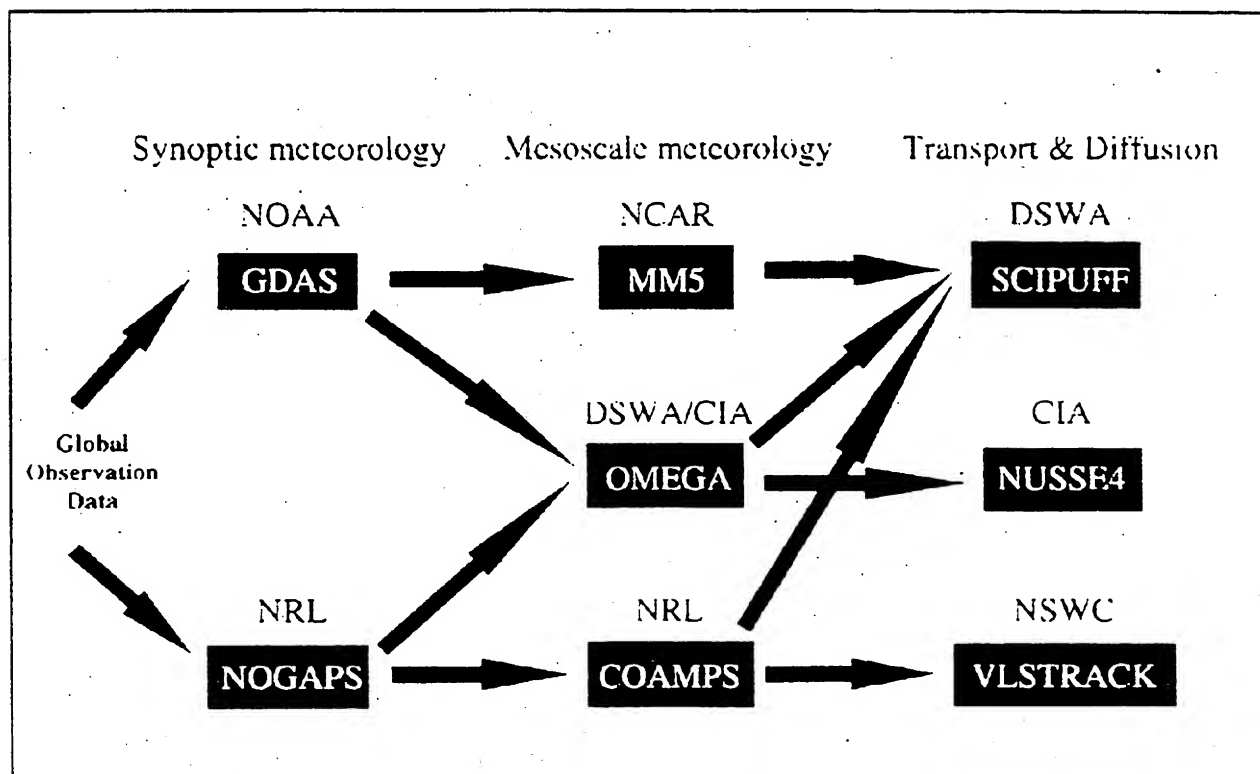
and an initial 6-kg liquid droplet mass. The liquid droplets had a mean size of 550 microns. The models (SCIPUFF, VLSTRACK, NUSSE4) then followed the agent cloud according to their respective algorithms.

The relative droplet mass is small—about 19 gallons—and the liquid droplets that comprise about half the initial chemical warfare agent cloud settle to the ground quickly. Once the liquid droplets reach the ground they spread, and the surface area from which the agent can evaporate increases. The subsequent



**Figure 15**

**Multiple Mathematical Models/Modelers Used in Various Combinations**



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### Validation of Predicted Meteorological Results Against Observations

The low-level wind directions generated by the multiple meteorological variations were compared to the soot vectors described earlier. The predictions from the models were generally consistent for a majority of variations.

Smoke dispersion from the Kuwaiti oilfield fires also was used to test the consistency of the meteorological variations with observed data. Figure 16 shows satellite imagery of these smoke plume trajectories over the Persian Gulf region on 11 March 1991. The heat from the fires caused the smoke to rise rapidly and to be transported in the planetary boundary layer as well

as the troposphere. Because the smoke absorbed heat from the sun as well, only an indirect comparison could be made with the model predictions, which do not include this effect. Most of the resulting smoke trajectories capture the general characteristics of the oilfield fires.

On the basis of the results of the comparison to soot patterns and the oilfield fires, the NOGAPS/COAMPS, GDAS/OMEGA, and GDAS/MM5 linkages were chosen as the baseline simulations for the dispersion calculations. These simulations gave the most realistic predictions, given their consistency with observed weather conditions.

release of agent, which comprised the bulk of the agent released into the atmosphere at Khamisiyah, included the evaporation from the liquid contamination as well as the persistent (over several days) evaporation from the absorbed liquid pools and saturated wood at the stack locations. Evaporation from wood and soil has been incorporated into each of the models to reflect the evaporation curves from the Dugway/Edgewood test results. The specific results from the Dugway evaporation tests (rather than the Edgewood results) have been used in order to err on the side of conservatism.

In addition, the diminution of the ground-level vapor agent concentration as it is transported downstream is entirely due to assessed changes in regional meteorological conditions, basically shifting winds and turbulent mixing. Depletion mechanisms such as agent degradation (for which modelers could not agree on a rate), photolysis, and vapor deposition were not used. The combined effect of these phenomena would be to diminish and limit the extent of the plume especially in the case of long-range transport, perhaps by as much as 40 percent. In addition, scattered rain showers in the area on 11 March, which could have caused additional hydrolysis, were not incorporated into our modeling effort because we could not be confident of their location. This more conservative approach is warranted, given that the primary value of the modeling effort was to provide medical and epidemiological researchers with this important tool.

### Estimate of the Plume: A Composite of Multiple Models

Uncertainties in the plume's trajectory are heavily dependent on the amount of meteorological data available. In addition, performing similar trajectory analyses with different dispersion models could lead to different conclusions. Therefore, the DoD/CIA modeling group chose to present a composite or union of five different meteorological/dispersion simulations—representing the outermost perimeter of all models overlaid—in order to define the extent of the plume. These five simulations, all of which use the baseline meteorological fields, are:

- NOGAPS/COAMPS/SCIPUFF.

- GDAS/OMEGA/SCIPUFF.
- GDAS/MM5/SCIPUFF.
- NOGAPS/COAMPS/VLSTRACK.
- GDAS/OMEGA/NUSSE4.

Turbulence-induced uncertainty is inherent in an atmospheric modeling effort. It particularly affects the predicted dosage levels. Models generally account for this by predicting that there is a 50-percent probability that a specific dosage level will fall within a given contour. In our effort, we modified the models to broaden the contours so that they predict that there is a 99-percent probability that a specific dosage will fall within a given contour, further increasing our confidence in the outcome.

### The Plume and Potential Troop Exposure

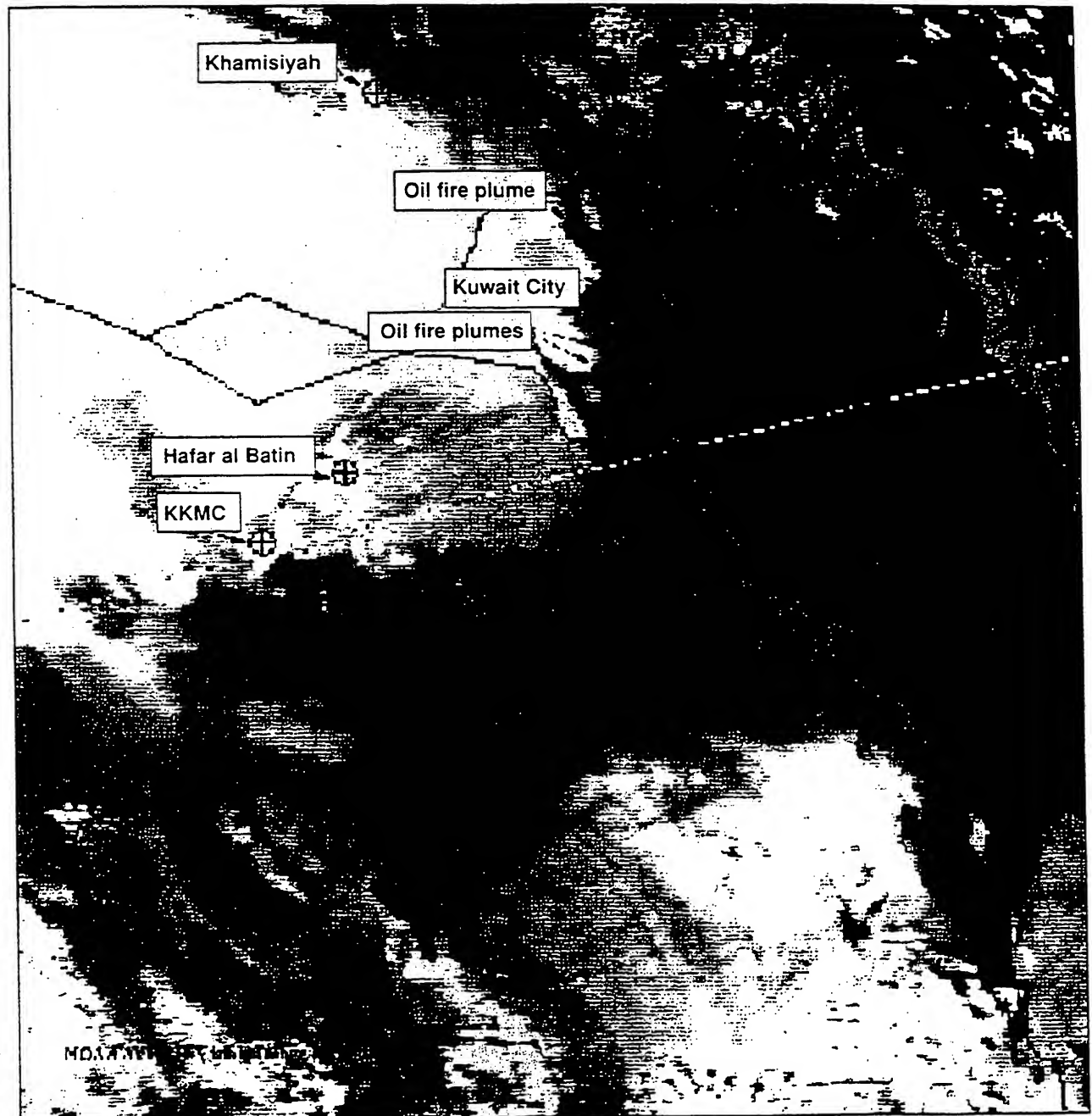
#### Dosages, Concentrations, and Limits

We decided to depict two levels of potential exposure in our modeling (note: a dosage is the amount or concentration of the agent to which a person at that location is exposed over a specific period of time):

- *First noticeable effects.* This is the dosage that would be expected to cause watery eyes, runny nose, tightness of chest, muscle twitching, sweating, and headache. Increasingly higher dosages would produce vision impairment, incapacitation, and death.
- *General population limit.* The dosage below which the general population, including children and older people, could be expected to remain 72 hours with no effects. (See figure 17 on toxicity.)

To understand the magnitude difference between the levels, note that the general population limit dosage (.01296 milligram-minute per cubic meter) is one-eighth of the dosage expected to produce noticeable effects (1 mg-min/m<sup>3</sup>). But the area between these levels, which we will call the area of low-level

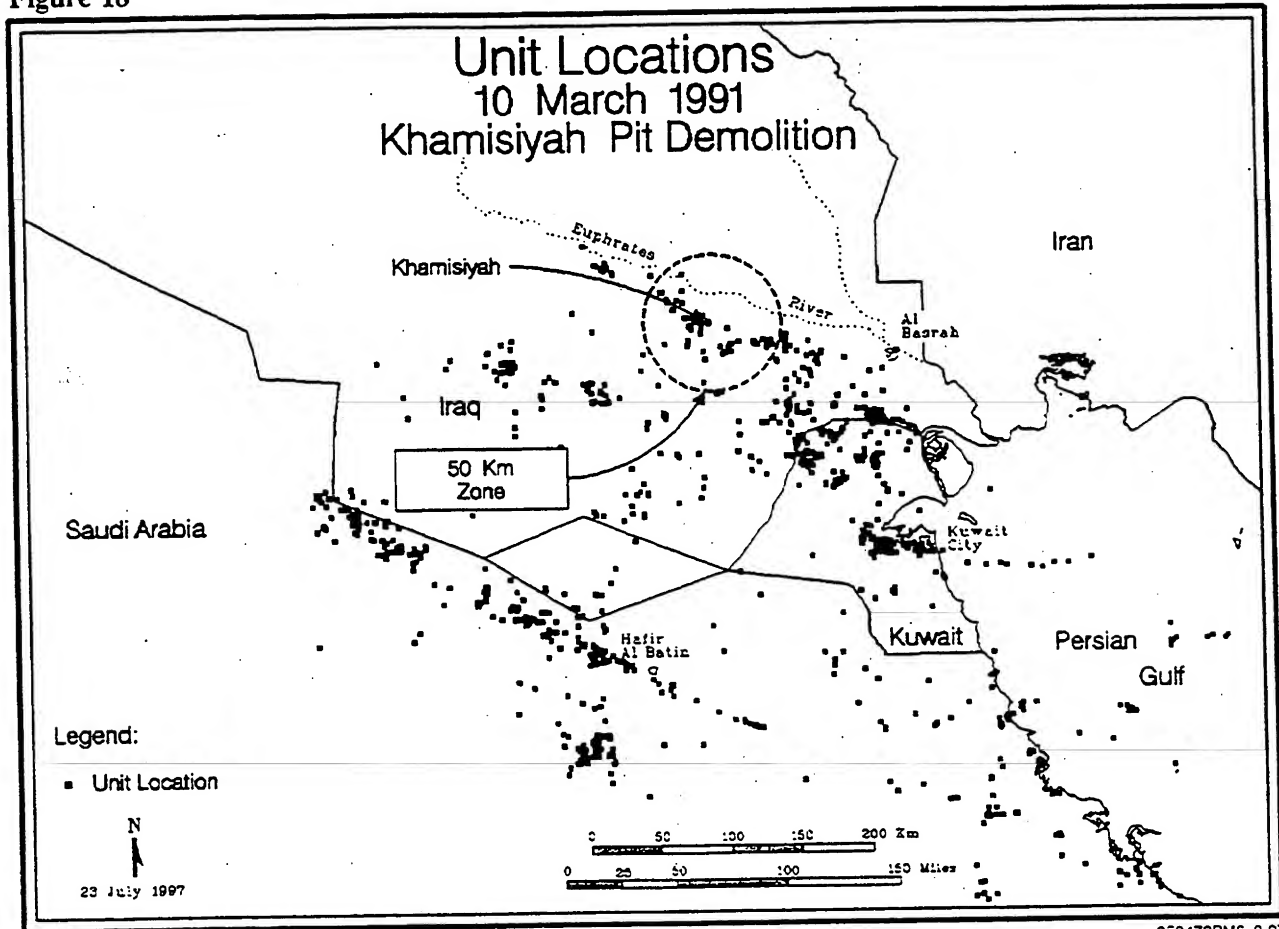
**Figure 16**  
**Meteorological Satellite Image of Kuwaiti Oil Fire Plumes, 11 March 1991**



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Figure 18



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XVIII Airborne Corps, it is not complete for the VII Corps. The S3-G3 conference for VII Corps is scheduled for September. The analysis that follows uses battalion-level data for the VII Corps; with more refined data the numbers are likely to be slightly lower.

#### The Plume Over Four Days

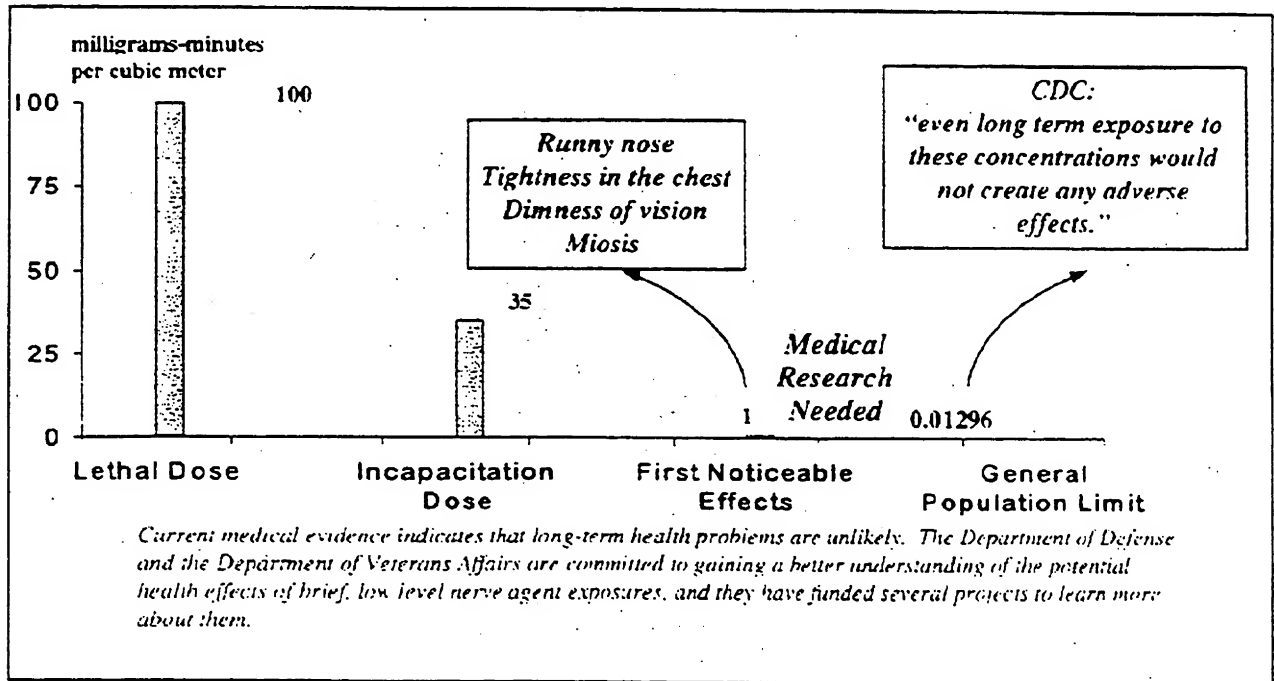
A closer look at the area with figure 19 shows the area of first noticeable effects on the first day (from 4:15 p.m. on 10 March 1991 to 3:00 a.m. on 11 March). This area is well within DoD's 50-km first-effects area from last year's survey effort.

The next map (figure 20) shows a closer view of the first-effects portion of the plume, which is about 20

km long and five km wide. No military units were located under the first-effects portion of the plume, which is consistent with the lack of reported effects and with DoD's survey results, which had over 99 percent of the respondents showing no signs of physical effects that could be correlated with exposure to sarin. The troops that performed the demolition had evacuated the area. As stated earlier, we know that one soldier involved in the demolition drove briefly through the smoke from the explosion. He had no ill health effects.

The small, 1.5-km-long peanut shape near the pit represents the area where DoD believes chemical alarms

**Figure 17**  
**Sarin Toxicity**



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exposure for this report, is the area for which medical research is needed. The exposure at Khamisiyah was relatively brief, measured in hours, not weeks, as would be the case with low-level occupational exposures. The coordinated efforts of VA, DoD, and HHS are ensuring research into better understanding this exposure issue.

#### **Last Year's 50 Kilometers and 20,000 Troops**

Last October, when it became clear that meaningful modeling of a potential release from the pit had come to a halt, DoD used the first noticeable effects limit to define a circle around Khamisiyah. On the basis of available literature and discussions with experts, DoD determined that one would have expected to see noticeable effects within 25 km of the demolition. Given the uncertainties at the time, DoD doubled that, and it was assessed that roughly 20,000 troops were within the 50-km circle so defined. DoD used this

assessment as a basis for mailing almost 20,000 surveys in an attempt to get additional information from the people that had been near Khamisiyah at the time of the demolition. DoD received 7,400 responses to the surveys, with over 99 percent showing no physical effects that could be correlated with exposure to the chemical warfare agent sarin.

Figure 18 depicts the Kuwaiti Theater of Operations with last year's 50-km circle around Khamisiyah and DoD's current understanding of military unit locations. Each dot represents where company-size units were located based on DoD's S3-G3 conferences. These conferences helped develop much better fidelity on the locations of troops, allowing DoD to move from battalion-level accounting to company-level accounting. While that has been completed for all of

Figure 20

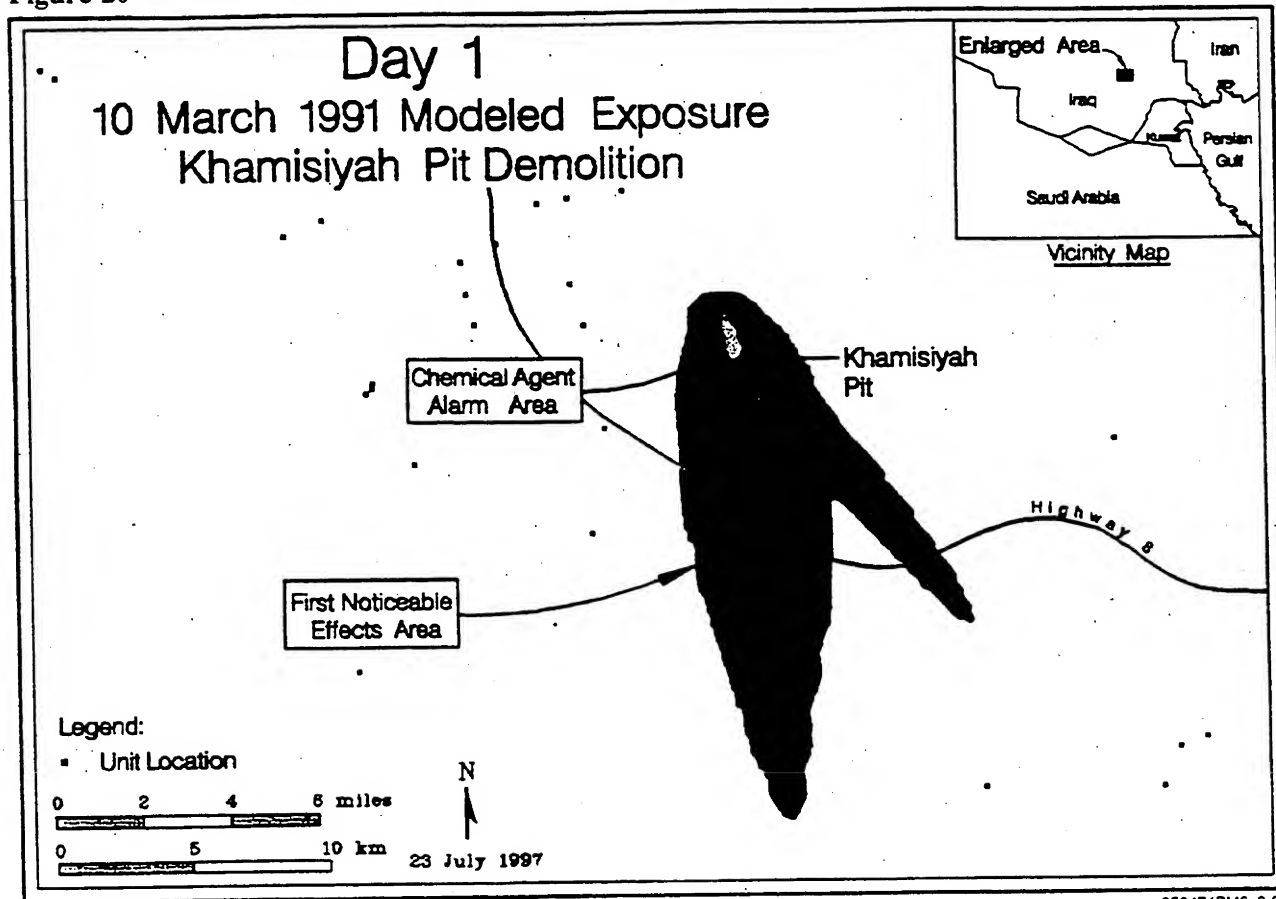
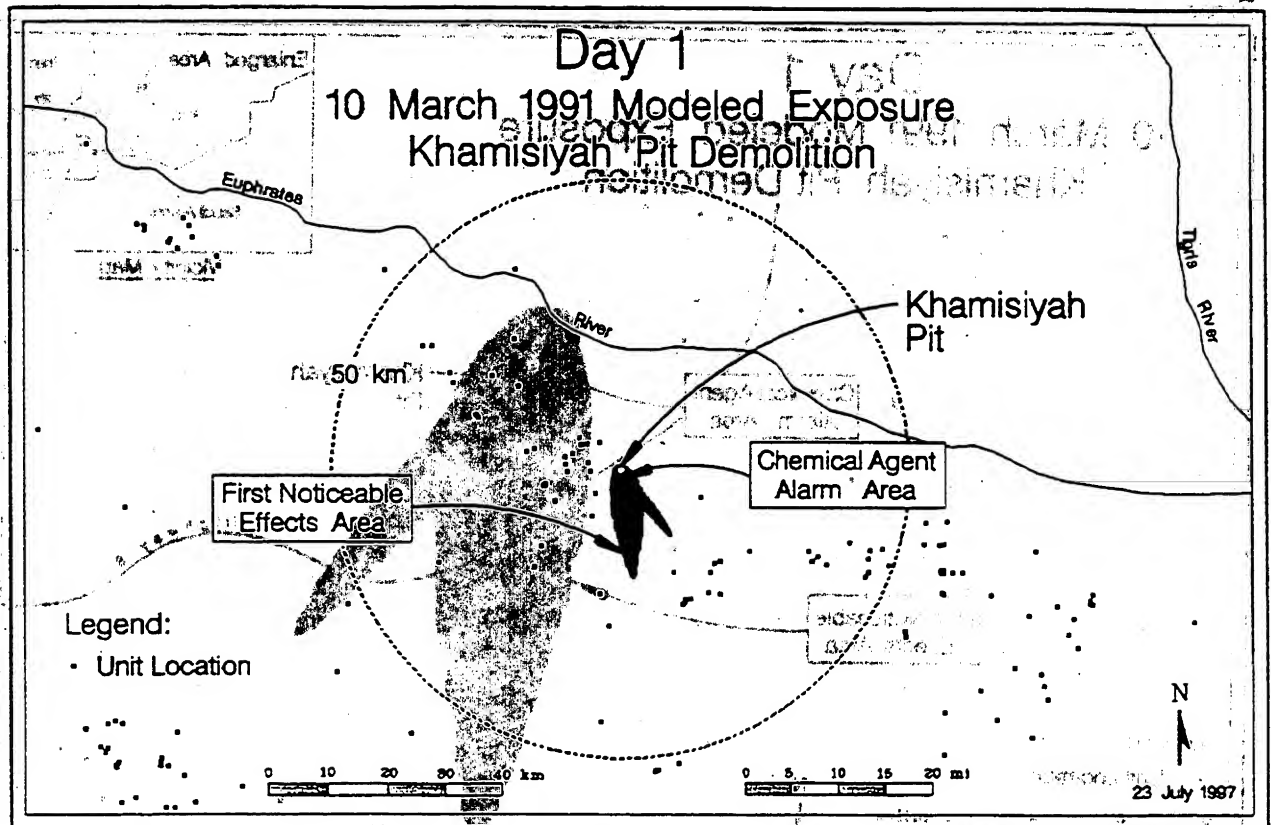


Figure 23 depicts the low-level exposure area, extending to the general population limit, for the first day. The wind has driven the chemical cloud south-southwest, extending almost 300 km and into Saudi Arabia. This potentially exposed almost 19,000 troops to low levels of chemical warfare agent. Remember that this plume is the composite of five models; the plumes from each individual model predicted smaller exposure areas. We used the composite approach to increase our confidence that the resulting plume would be our best estimate of the potential area covered, taking into account individual model biases. This approach was critical for notifications and for future epidemiological studies. However, we do not expect that everyone under the composite plume was exposed.

The map for the second day (figure 24) shows the effects of significant wind changes, thickening the plume and shifting it toward the west. This is the day of the highest potential low-level exposure, possibly affecting 79,000 troops, including some at King Khalid Military City. The initial cloud continued to move downrange, and the constant evaporation of agent from the sand and wood continued to refresh the plume, sending new tendrils from the pit.

By the third day (figure 25), the agent in the atmosphere in the south had dispersed to levels below the general population limit. Evaporation continued to feed the plume, which, because of additional wind changes, was moving several directions, predomi-

Figure 19



would have gone off had they been used. A note of caution, however: all plume areas depicted in this report are based on dosage levels—concentrations over time. The alarms are designed to go off based on concentrations, recycling every 20 seconds, that would cause incapacitation or death.

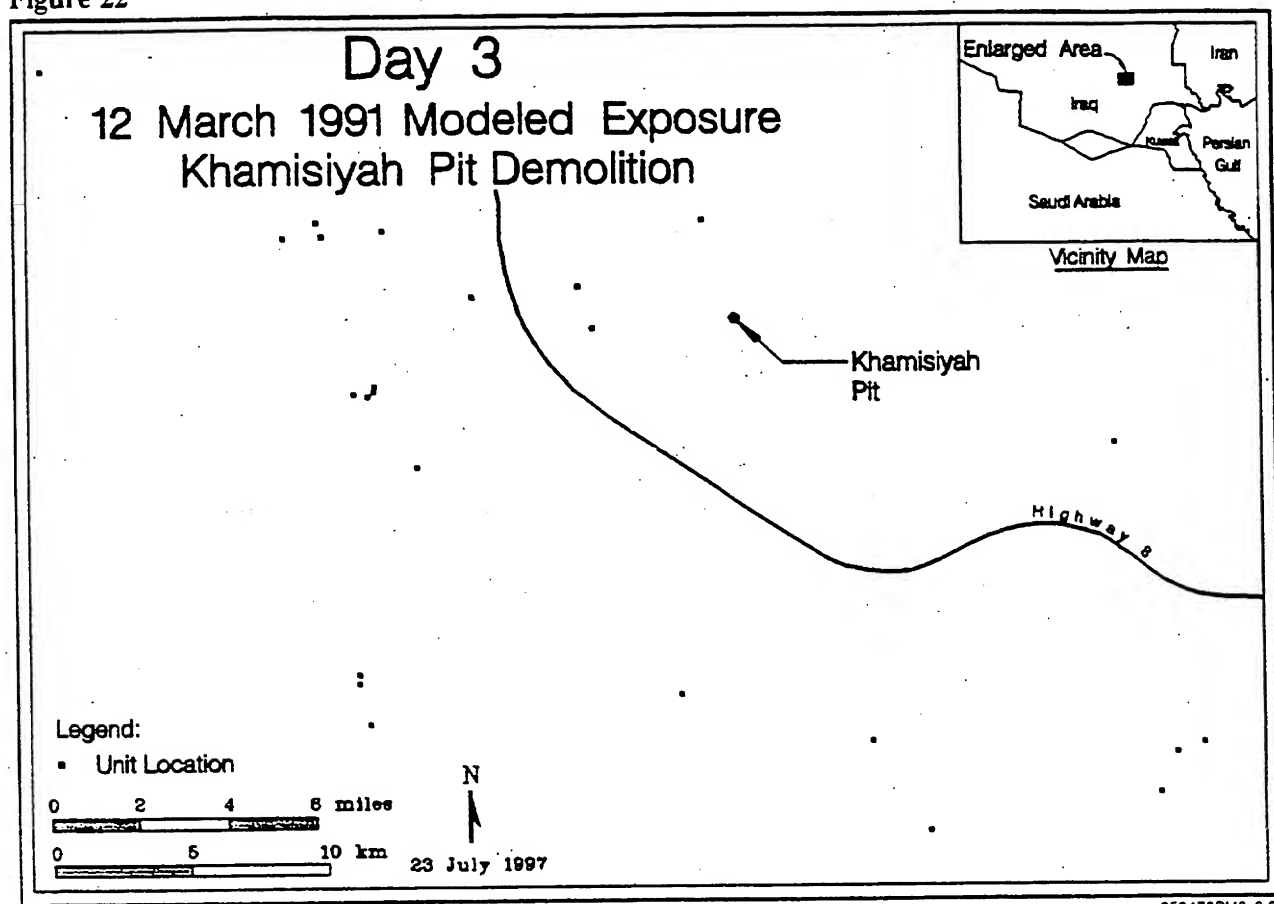
The offshoot portion of the plume is a product of using a composite or union approach in our modeling. While all five models produced first effects plumes for the first day that pointed south, one model also depicted a portion of the plume moving to the south-east. Our inclusion of the latter model graphically illustrates our approach in drawing the outer boundary of the overlaid plumes.

The next map (figure 21) shows the first-effects plume for the second day. It is an area about six km across

and six km deep. This is the result of a smaller area being generated by the evaporation of agent from the soil and wood. This evaporation is a critical component of the plume, making up almost 90 percent of the plume. We would not have expected the evaporation from the wood without the Dugway testing. We had thought there would be an instantaneous release into the atmosphere with some evaporation from the soil, but the Dugway testing showed that the spill into the wood and subsequent evaporation would be a very important factor.

By the third day, as the next map (figure 22) shows, the evaporation is not producing dosage levels above the first noticeable effects limit. However, the evaporation makes the low-level event last a few days.

Figure 22



would be counted on multiple days. The total, eliminating double-counting, is nearly 99,000.

## Next Steps

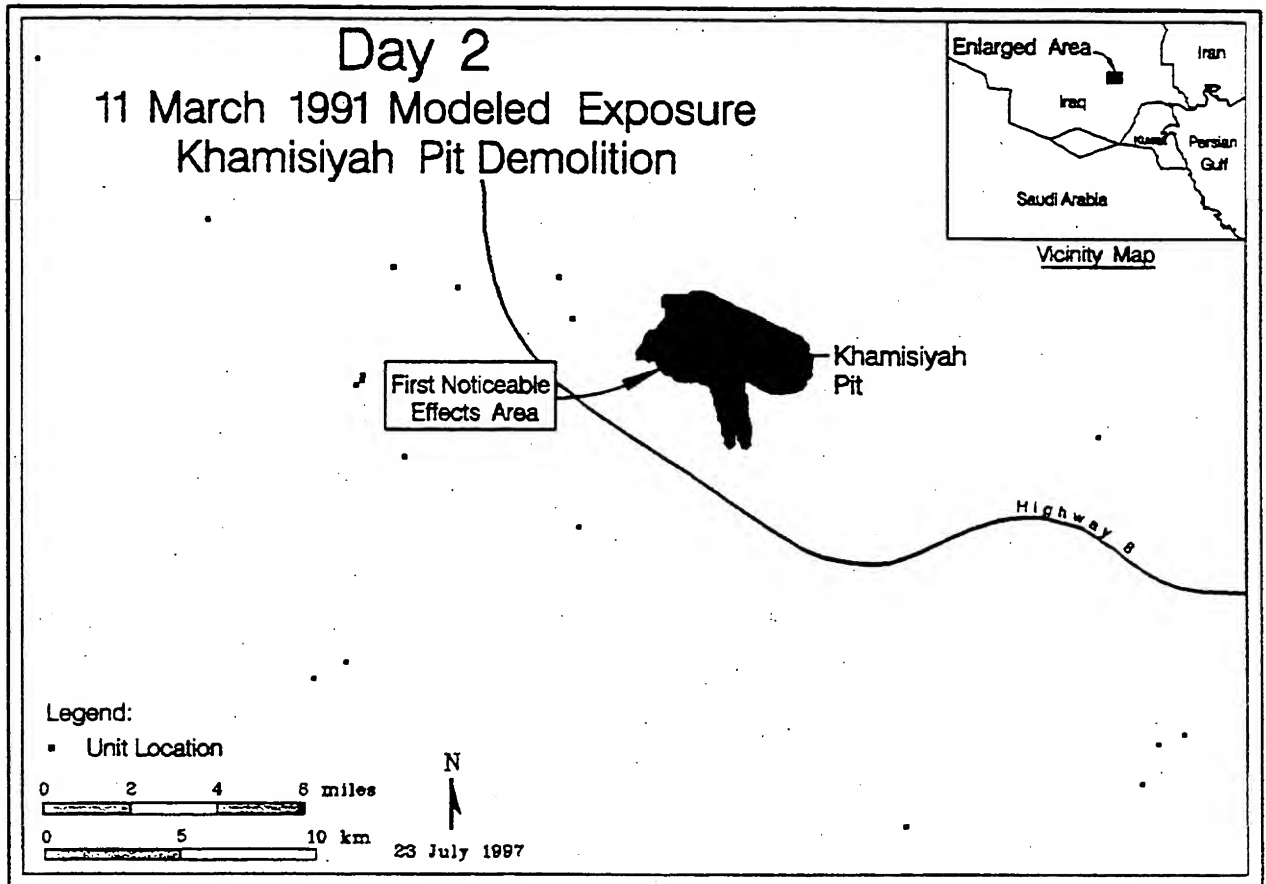
### Epidemiological Work

The plume developed by our modeling efforts constitutes our best estimate of the potential exposure and will become a critical input for continued medical and epidemiological research. The concentrations and dosages people were potentially exposed to are essential to some of that work. The maps in this paper reflect only two levels of dosage and were developed using one location for a unit each day, even though we know they were moving. For the detailed epidemiological

work ahead, each plume's dosage contours will be provided, and DoD will develop profiles for individual units that show their exposure over time—both with the concentration they had at any point in time and with the cumulative dosage. That will become a part of the ongoing medical research program. The number of troops who have been exposed to very low levels remain a concern, both immediately and in the long run. We need to understand, through our epidemiological and medical work, the effects of low-level chemical exposure for our veterans now and for the future.



Figure 21



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nantly up the Euphrates valley. Up to 3,300 troops were exposed on this day.

The map for the fourth day (figure 26) shows a small plume from evaporation moving to the northeast, potentially exposing two battalions of troops there, about 1,600. After that, any additional evaporation did not exceed the general population limit.

The table reflects the daily totals. As already indicated, no units appear to have been exposed to dosages causing first noticeable effects. Moreover, the daily numbers for low-level exposure do not sum to the total exposed population, because some troops

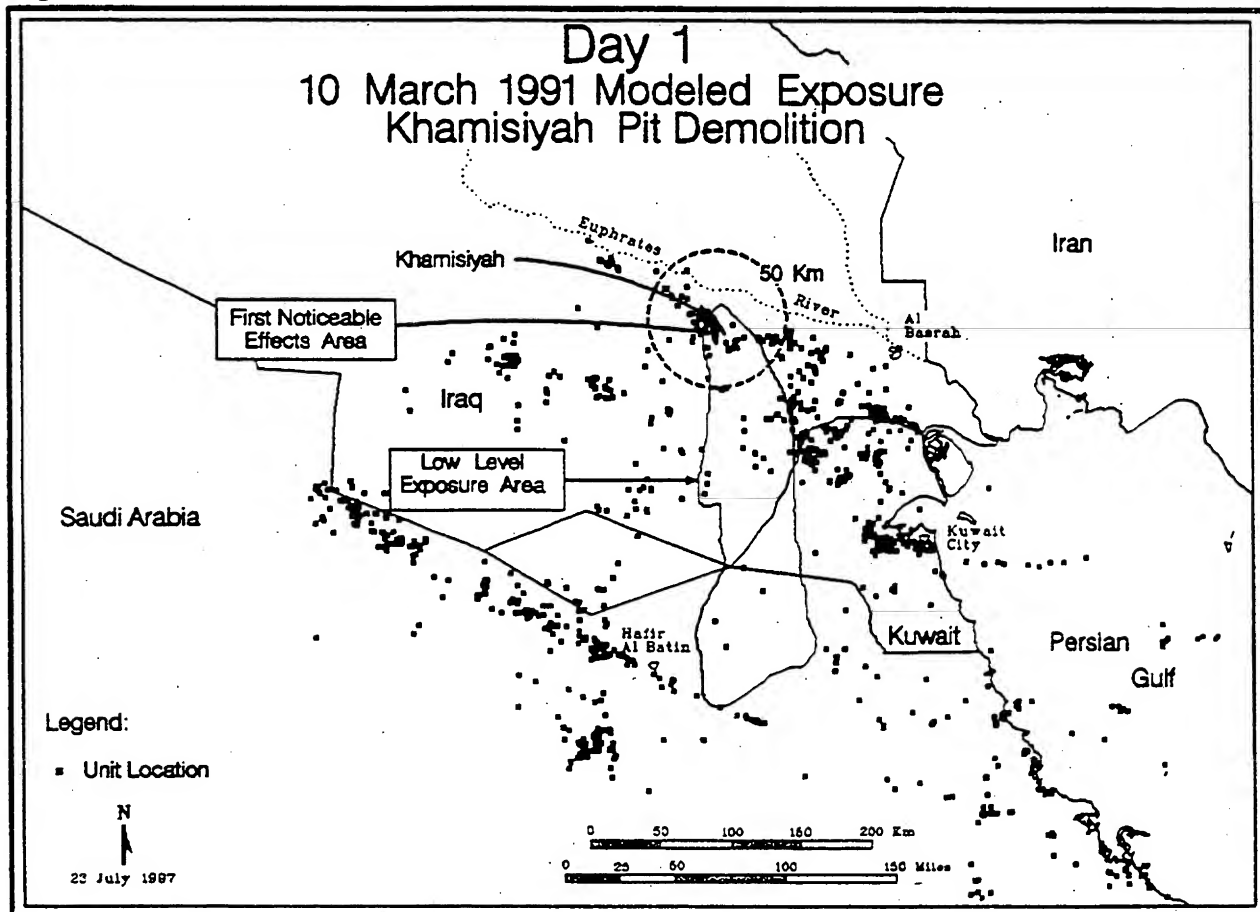
#### US Forces Potentially Exposed to Nerve Agent

*Number of troops by day*

Date	Day	First Noticeable Effects	Low Level*
March 10	1	0	18,814
March 11	2	0	79,058
March 12	3	0	3,287
March 13	4	0	1,638

\* Because people are counted on multiple days, the numbers do not sum to the total exposed population of 98,910.

Figure 23



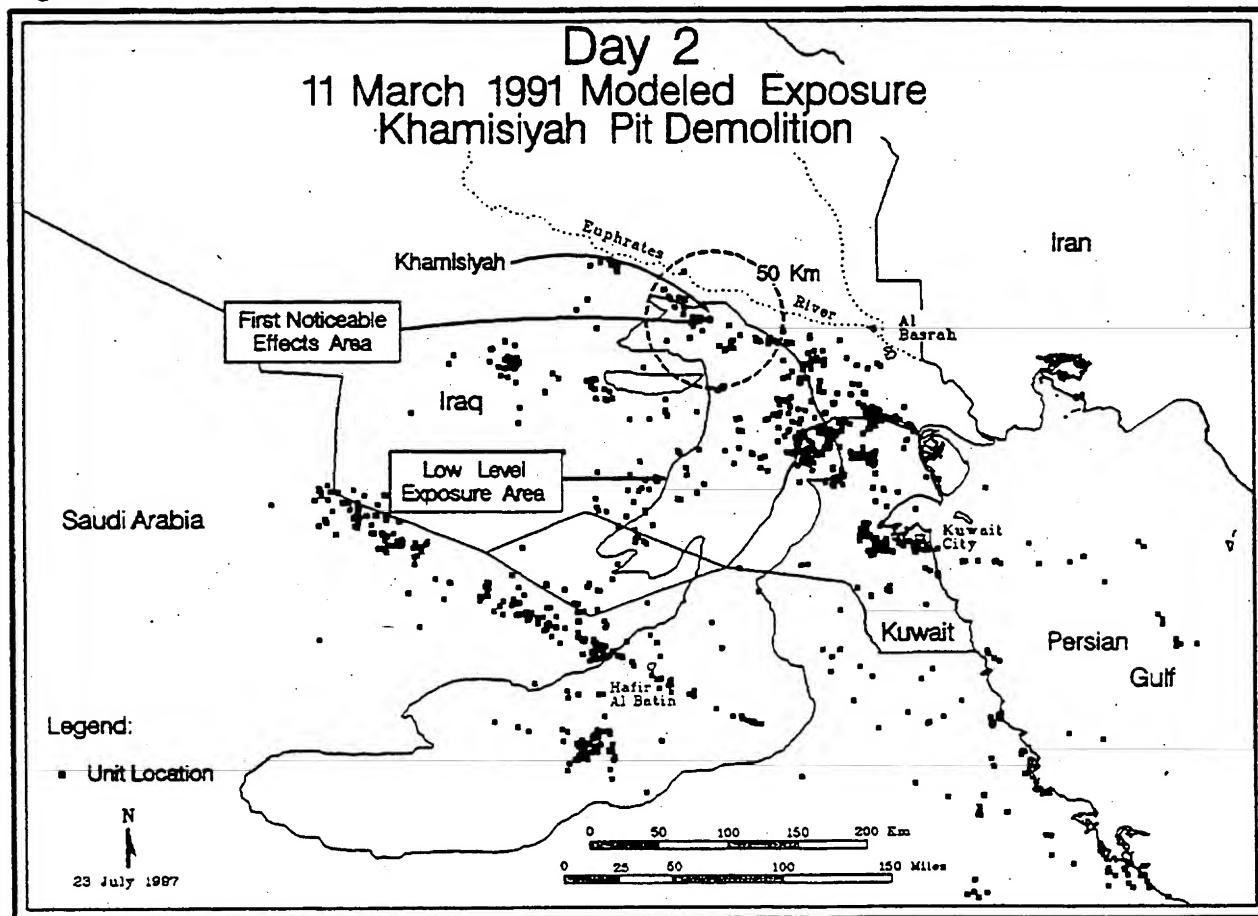
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### Continued Support to the Veterans

DoD has sent two different letters of notification. The first were to the 99,000 that were under the composite plume, indicating that we believe they may have been exposed to low levels of chemical warfare agent. Current medical assessments suggest that there are no long-term health consequences, but that if veterans have any concerns, they should contact DoD or VA. The second letter went to those who received one of the 20,000 surveys last year but were not under our modeled plume. That letter indicates that our best assessment suggests that they were not exposed.

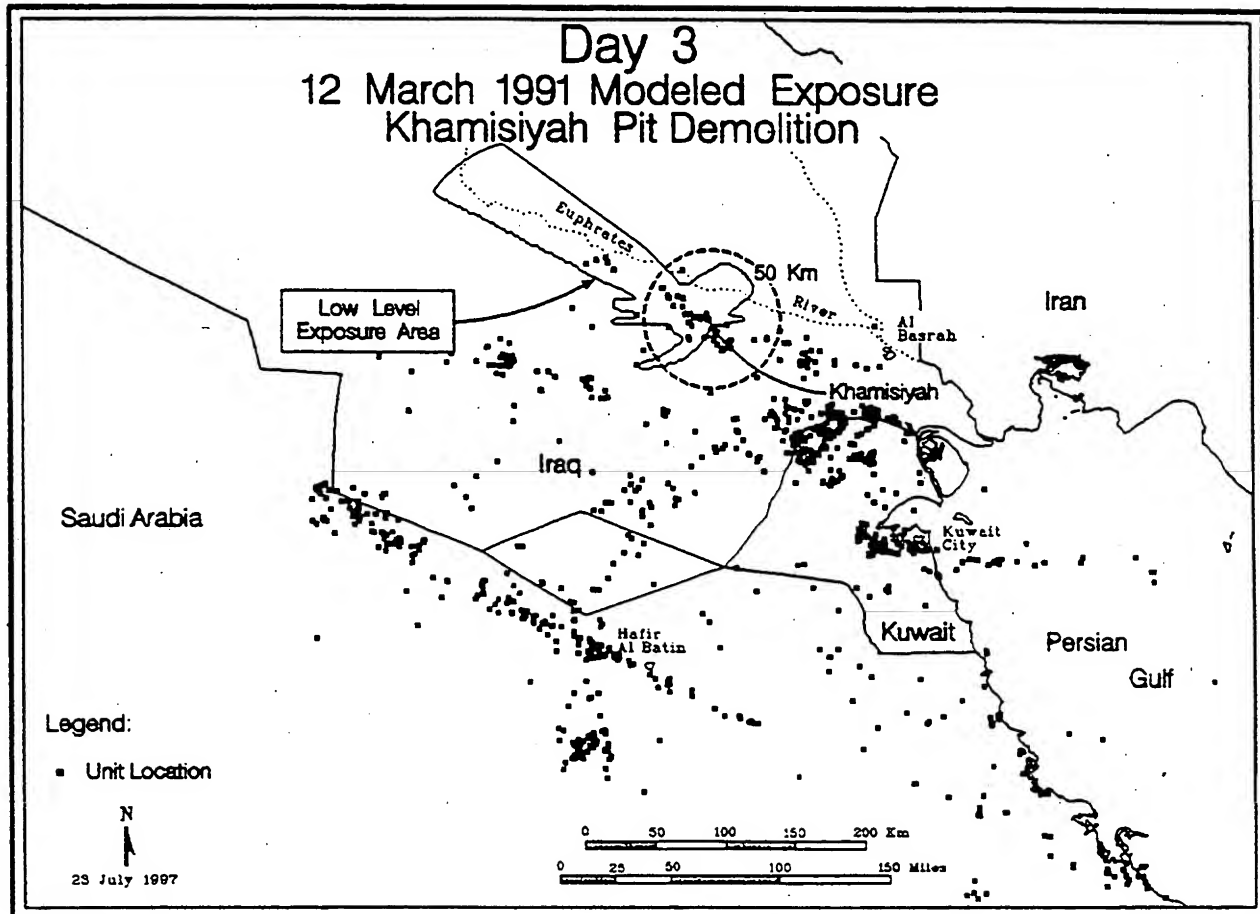
As we have stated, if anyone who served in the Gulf has any concern about their health, whether they were at Khamisiyah or not, they should be examined at a DoD or VA facility. Hotline numbers are 1-800-796-9699 and 1-800-PGW-VETS, respectively. We will answer questions and ensure that the callers get the medical treatment they need and deserve. Those desiring to contact CIA for questions on modeling or other issues in which intelligence support could help, call the Agency's Public Affairs number: 703-482-7754.

Figure 24



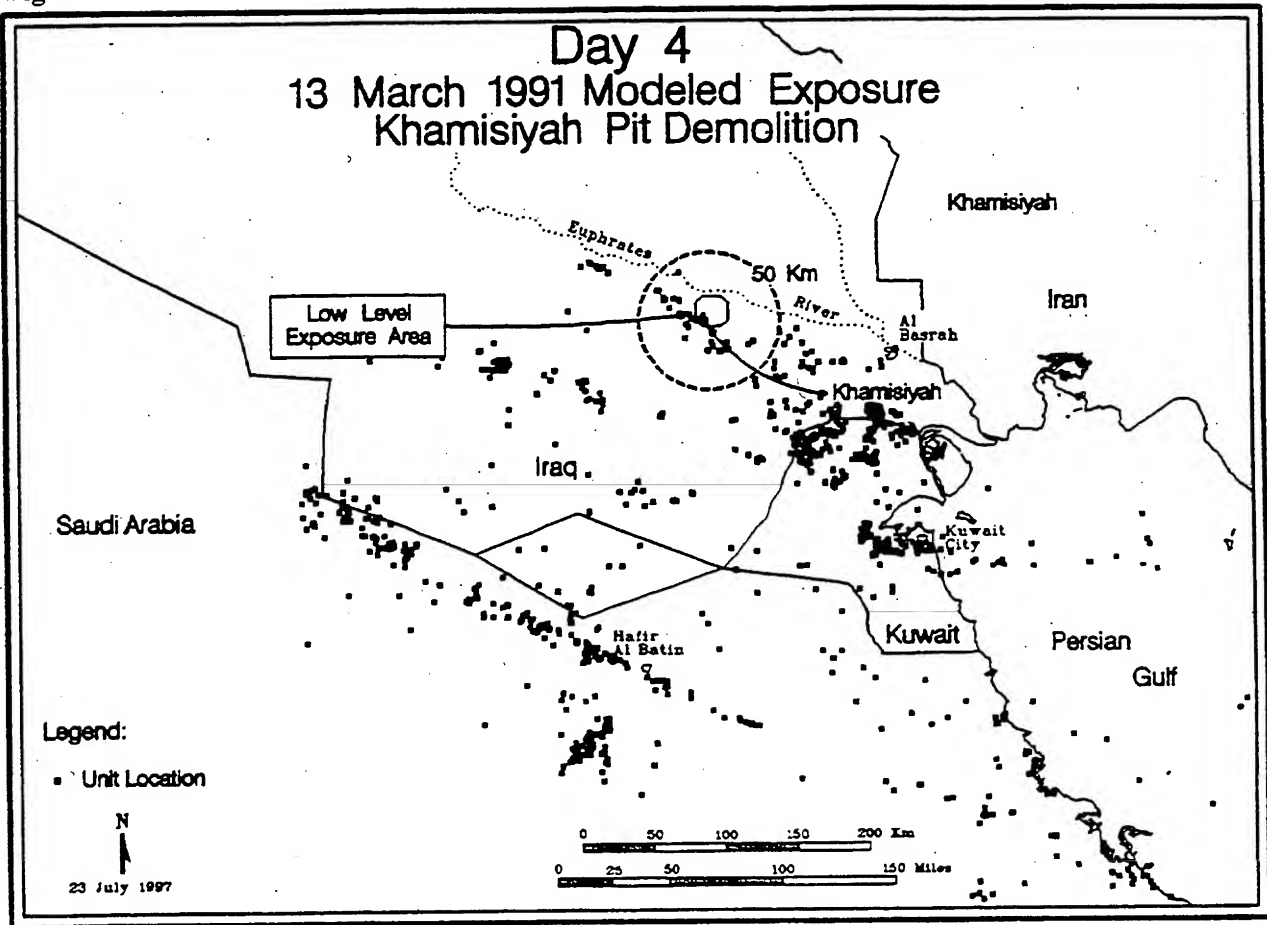
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Figure 25



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Figure 26



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*Persian Gulf War  
Illnesses Task Force*

# **Khamisiyah: A Historical Perspective on Related Intelligence**

9 April 1997


**Introductory Note  
From the Acting  
Director of Central  
Intelligence**

On February 27, in response to President Clinton's tasking to his Advisory Committee (PAC) on Gulf War Veterans' Illnesses, I appointed Robert Walpole to be my Special Assistant for this issue. I asked him to have a Persian Gulf War Illnesses Task Force running by 3 March. One of its first tasks was to determine what the Intelligence Community knew about the Khamisiyah storage facility, when we knew it, and what we did with that information. Former task forces had focused on identifying areas of potential exposure to chemical agents and on assessing what had happened in March 1991 at Khamisiyah.

This paper and the accompanying documents do not contradict previous intelligence warnings before Desert Shield/Desert Storm: that Iraq was likely to have chemical warfare (CW) munitions in the theater of operations and that Iraqi CW munitions might not be marked. It also does not change our judgment that Iraq did not use chemical weapons during Desert Storm.

The paper does, however, illustrate that intelligence support associated with Operations Desert Shield and Desert Storm—particularly in the areas of information distribution and analysis—should have been better. Key issues include problems with multiple databases; limited sharing of “sensitive” but vital information; and incomplete searches of files while preparing lists of known or suspect CW facilities. This Task Force is preparing recommendations to address these problems and will continue to assess how we can improve. We will move aggressively to implement those recommendations.

Finally, I would like to thank the United Nations Special Commission for its part in this public release of information. I also want to reiterate my commitment to the men and women who served this country in the Persian Gulf. We owe them a full and accurate accounting of what happened. This paper is a part of that commitment. But this commitment also extends to enhancing intelligence support to men and women who will serve in the future.

A handwritten signature in black ink, appearing to read "George J. Tenet", with a stylized flourish at the end.

George J. Tenet

## Khamisiyah: A Historical Perspective on Related Intelligence

The US Intelligence Community (IC)<sup>1</sup> has assessed that Iraq did not use chemical weapons during the Gulf war. However, based on a comprehensive review of intelligence information and relevant information made available by the United Nations Special Commission (UNSCOM), we conclude that chemical warfare (CW) agent was released as a result of US postwar demolition of rockets with chemical warheads in a bunker (called Bunker 73 by Iraq) and a pit in an area known as Khamisiyah.

### Iraq's Chemical Warfare Program

Before the Persian Gulf war, the IC assessed that Iraq had a significant chemical weapons capability, including chemically armed Scuds. The IC also assessed that Iraq had used chemical weapons on numerous occasions against Iran and its own citizens. At the time of the US deployments to the Persian Gulf, the IC had reached consensus that Iraq had chemical weapons in its arsenal, had likely forward-deployed these weapons, and was prepared to use them against Coalition forces.

When Desert Shield began, our concerns about the Iraqi use of weapons of mass destruction became the focus of our chemical weapons analytic and collection efforts. IC analysts sought to identify possible Iraqi CW facilities for targeting purposes. Sites throughout Iraq were identified, albeit on incomplete information.

Several CIA chemical and biological warfare analysts maintained internal 24-hour coverage during the start of the air war and later through the ground campaign to provide support to senior CIA officials and key



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policymakers. Although there were many reports of chemical weapons use, analysis of all-source information indicated that these were false alarms and that chemical weapons were not used. CIA later published an assessment concluding that Iraq had never deployed chemical weapons to its frontline units, subsequently decided to move them out of the theater prior to war, and never used them against Coalition forces.

In the months immediately following the Gulf war, the IC turned its assets to identifying and characterizing Iraq's surviving CW and other weapons-of-

<sup>1</sup> The Intelligence Community comprises the Central Intelligence Agency, Defense Intelligence Agency, Bureau of Intelligence and Research (State), National Security Agency, National Imagery and Mapping Agency, and several other organizations within the Departments of Defense, Treasury, Justice, and Energy.





*Figure 2. Predemolition photo of Khamisiyah ammunition storage area showing Bunker 73 and pit area. Darkened areas indicate bomb craters.*

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mass-destruction capabilities. As the following intelligence chronology demonstrates, the IC did not focus on the possible release of chemical agent until after veterans' health concerns surfaced.

### **Intelligence Chronology of the Khamisiyah Depot**

When viewed with the clarity of hindsight, the history of events at the Khamisiyah facility appears relatively simple. The following intelligence chronology, however, underscores the complexity of the issue and the ambiguity intelligence analysts face in piecing together sometimes conflicting information.

The IC has access to a large volume and multiple sources of information, but individual analysts rarely have access to all information on a given topic. Furthermore, not all information we receive is clear or correct. Analysts normally must sort through large volumes of reporting, much of which is contradictory, inaccurate, incomplete, or ambiguous, to reach a single analytic judgment. Finally, resource constraints and conflicting priorities limit the number of intelligence issues that can be addressed in depth.<sup>2</sup>

Intelligence on Khamisiyah was buried in a large volume of reporting that needed to be sorted and analyzed. Only after a massive interagency effort was this evidence identified, isolated, analyzed, and prepared for release. The sheer volume of reporting on Iraq greatly complicated our ability to single out this one facility—which was only a small part of the Iraqi CW effort—and properly exploit information once received. We will continue to search for relevant documents and to release useful information.

### **The Intelligence Record: 1976-90**

Before its demolition by US forces in 1991, the Khamisiyah facility was a large ammunition storage

depot in southeastern Iraq, approximately 100 kilometers (km) from the Kuwaiti border. The facility we now call Khamisiyah was first identified in intelligence information from September 1976, while it was under construction. The IC identified the facility as a conventional ammunition depot. In June 1977, it was assigned the name Tall al Lahm—after a nearby town—in our imagery database. [1] This remained the most common name the United States used for the facility until mid-1996, when the name used by the Iraqis—Khamisiyah—was adopted to avoid confusion. Information available to the IC identified the facility's location as 304700N/0462615E. [1]

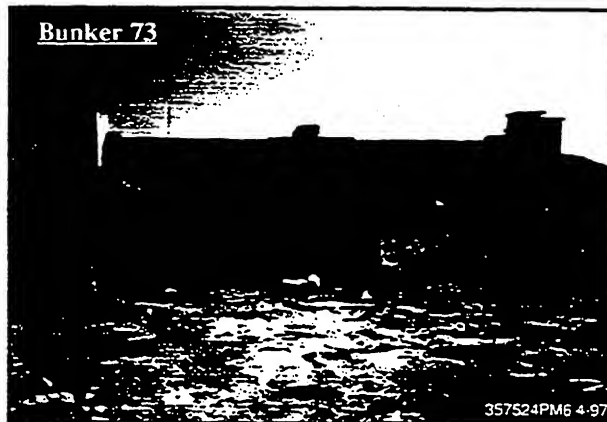
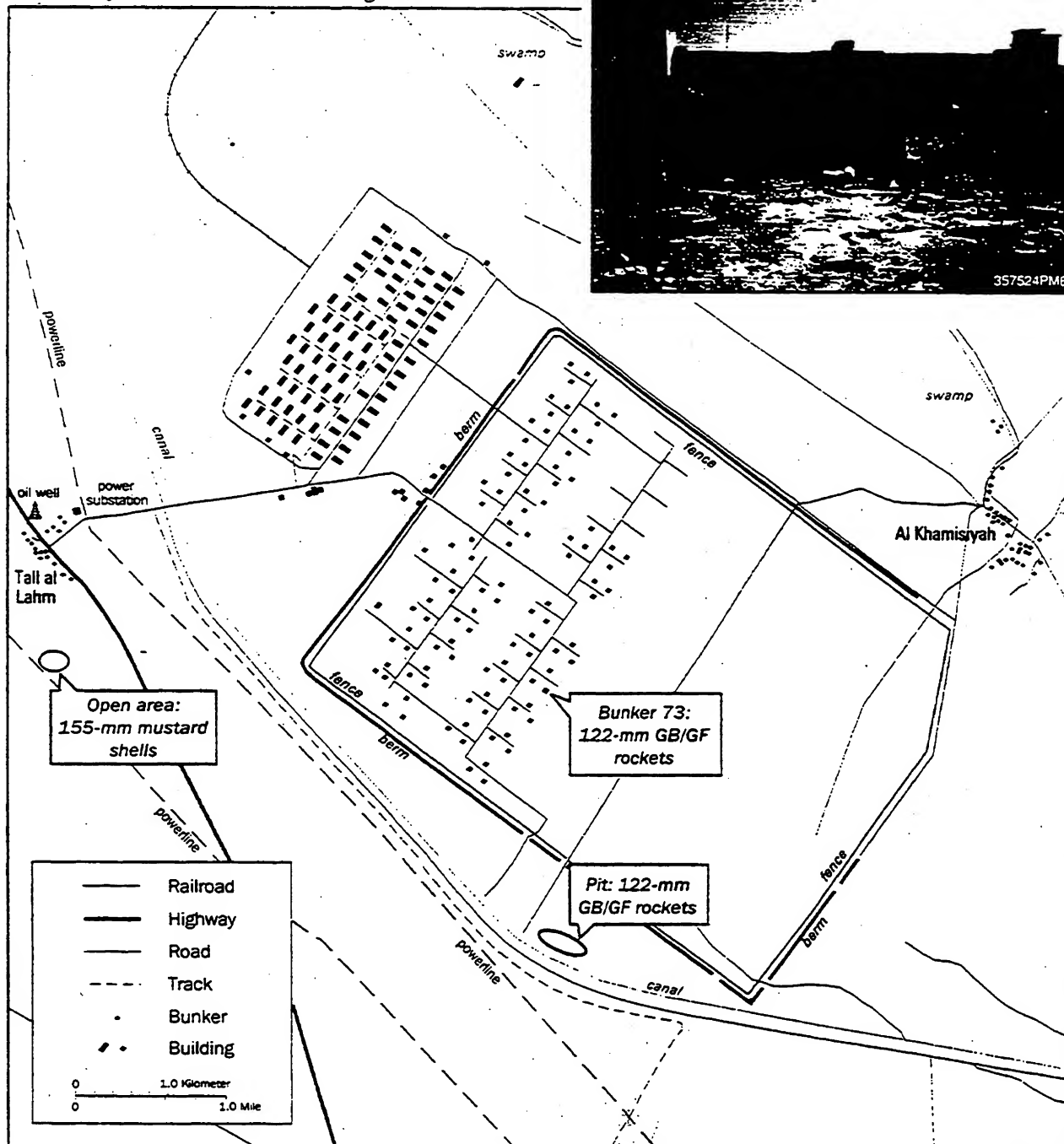
The first known reference to the depot using the Iraqi name Khamisiyah occurred in intelligence reporting in April 1982, when the "Al Khamisiyah ammunition depot" was mentioned in connection with the transfer of munitions in support of Iraqi military operations during the Iran-Iraq war. [2] This report did not specify the facility's location, but subsequent reporting associated it with the geographic coordinates of the nearby town of Khamisiyah (3046N/04629E). [3] Neither this reporting nor the intelligence from 1976 hinted at any connection with chemical weapons. This facility was maintained in a National Security Agency database as Khamisiyah, and in the imagery database as Tall al Lahm. No apparent effort at the time was made to reconcile the facility names.

While not discovered until 20 March 1997, intelligence acquired in July 1984 currently provides the earliest potential indication that chemical weapons or chemical warfare activities might have been associated with the Khamisiyah depot at the time. As part of an ongoing review of historical files on Khamisiyah, we discovered information indicating that a decontamination vehicle normally associated with tactical chemical defense was at the depot. This activity was not associated with any specific bunker or other storage structure and, by itself, does not provide confirmation of chemical weapons storage.

The first recognized connection between Khamisiyah and chemical weapons—and the only such evidence prior to Iraq's August 1990 invasion of Kuwait—

<sup>2</sup> Although monitoring Iraq's CW program in general remained a high priority, available collection and analytic resources were focused on key production-related facilities rather than storage sites. In addition, CW analysts were also responsible for monitoring critical developments in countries such as Libya, Iran, and Russia.

# Khamisiyah Ammunition Storage Area



appeared in a CIA human-source report obtained in May 1986.<sup>3</sup> This report was a translated copy of an Iraqi CW production plan and discussed the transfer of chemical weapons to Khamisiyah:

3,975 155-mm mustard-loaded artillery grenades [sic] have been issued (from June 1984 to March 1985) to al-Khamisiyah warehouses. We do not have official data about using this quantity by the third army corps. The warehouses currently have 6,293 150-mm mustard bombs [sic], enough to meet front demands for four days on a 15-minute mission.<sup>4</sup> [4]

This report was made available to select individuals in the policy and intelligence communities—including DoD officials—but did not receive broad distribution because of its sensitivity.<sup>5</sup> Of note, the munitions mentioned above were artillery shells containing mustard agent. Thus, they were different from those blown up by US troops at Khamisiyah in 1991; those were 122-mm rockets containing the nerve agents sarin and GF, which—according to Iraqi declarations—were moved to Khamisiyah in January 1991.

A CIA assessment in November 1986 used the above information to conclude that chemical weapons were stored during the Iran-Iraq war “at the southern forward ammunition depot located at Tall al Lahm.”<sup>6</sup>

<sup>3</sup> Two previous efforts by CIA to describe its assessment of what we knew about Khamisiyah were imprecise, and were contradictory with the fact that we had associated chemical weapons with the Khamisiyah facility in 1986. These previous efforts were a chronology transmitted to DoD on 24 January 1997 for its preparation of the Khamisiyah Case Narrative, and a 26 February 1997 Fact Sheet. One of the purposes of this paper is to set the record straight.

<sup>4</sup> At the time these weapons were first moved to Khamisiyah, Iraq had just begun to use large numbers of chemical weapons on the battlefield, although the Iran-Iraq war had been under way for nearly four years. Analysts viewed Iraqi CW practices in the early years of its CW program to be haphazard, and not indicative of routines established once the program matured.

<sup>5</sup> Limiting access to very sensitive reports is an important measure in ensuring anonymity of the report's source, whose life would almost certainly be at risk if his government discovered his identity. Because of such sensitivity, however, this report—and other sensitive reports cited in this chronology—were not available electronically and were not easily retrievable by analysts doing retrospective analysis.

<sup>6</sup> This assessment was one of many routine IC reports on Iraq's CW program and was distributed to DoD and other elements of the policy and intelligence communities.

This assessment shows that a connection had been made at that time between Khamisiyah and what we knew as Tall al Lahm. It also stated that “a new generation of 16 bunkers will expand Iraq's capability to store CW munitions at six airfields and at three ammunition storage depots that are strategically located throughout the country.” [5] Subsequent analytic efforts focused on this new generation of bunkers—dubbed “S-shaped” bunkers by the IC because of their unusual shape—as the most likely storage sites for forward-deployed Iraqi chemical weapons. [5] None of these bunkers was located at Khamisiyah: the nearest were located at Tallil Airfield and the An Nasiriyah Southwest depot. Over time, the IC developed a bias toward the S-shaped bunkers as intended for CW storage. By 1991, this bias led analysts to conclude, erroneously, that reporting about Khamisiyah referred to the An Nasiriyah SW depot.

Reporting from early 1988 with the same high reliability, sensitivity, and handling as the May 1986 report, stated with regard to Iraqi chemical weapons storage locations:

As of early 1988, Iraqi artillery shells, bombs, and rockets loaded with chemical warfare (CW) materials were stored either at Samarra or in a large ammunition dump near the town of Muhammadiyat. This facility was located about 12 [sic] kilometers outside of Baghdad. Additionally, 122-mm rockets temporarily were stored at the airbase in Kirkuk for further transport to Sulaymaniyah. [6]

This report, especially with the “either-or” construction, suggested that chemical weapons were not stored at Khamisiyah or any other location in southern Iraq at that time. In addition—because we had previously identified an S-shaped bunker at Kirkuk airfield—mention of CW storage at “the airbase in Kirkuk” in the 1988 report further strengthened the IC's focus on S-shaped bunkers and the assessment that they would be used for forward deployment of chemical munitions, but were not intended for long-term storage.

This information, the strengthened analytic bias toward S-shaped bunkers, and several other factors

may have played a role in Khamisiyah's omission from CW facility lists generated by the IC between 1986 and 1991. For example, following the May 1986 report and the November 1986 assessment, some analysts believed the reported activity at Khamisiyah represented temporary, forward-deployed storage.<sup>7</sup> We have located no additional reporting suggesting chemical weapons were stored at Khamisiyah from May 1986 to the end of the Iran-Iraq war in 1988—a period in which Iraq used thousands of tons of CW agents against Iran.

#### **Operations Desert Shield/Desert Storm: August 1990–February 1991**

Additional information concerning possible chemical weapons storage at Khamisiyah was obtained shortly after Iraq invaded Kuwait, but was not recognized until early 1996 during a review of the Khamisiyah facility as a possible CW agent release site. Intelligence acquired on 18 August 1990 showed what was reported only as munitions transloading activity. Because CW analysts did not carry Khamisiyah on their lists of CW-related facilities in 1990, the information was not reviewed by chemical weapons specialists at the time. We now judge that this activity might have been a chemical weapons transfer under way outside a bunker at Khamisiyah; we have determined that this was not Bunker 73.

Khamisiyah was not mentioned as a chemical weapons storage location in any finished intelligence document or list of facilities produced during the months leading up to Desert Storm. At the time, the IC unanimously identified S-shaped bunkers as the most likely locations for forward deployment of chemical weapons when tasked to identify Iraqi CW facilities. As a result, Khamisiyah was not added to IC lists of suspect Iraqi CW facilities. Analysts emphasized at the time, however, that chemical weapons could be stored

<sup>7</sup> Forward-deployed storage, by definition, is deemed to be temporary; that is, for use during wartime-related operations. Nevertheless, analytical judgments about the forward-deployed usage of Khamisiyah, either at that time or currently, should not be misinterpreted as a justification for the facility's not being listed as a potential chemical weapons storage site prior to Desert Storm. Given the uncertainties at the time about locations of Iraq's CW stockpile, IC lists of suspected chemical weapons storage facilities should have been broader and should have included sites at which chemical weapons had previously been stored.

anywhere—even in the open. [7] Nevertheless, the Tall al Lahm facility was mentioned in 28 February 1991 military intelligence information requests as suspected to have possibly contained chemical munitions prior to the ground war. [8]

A report pertaining to chemical weapons at a location we now know to be Khamisiyah was obtained during Desert Storm. On 23 February 1991, a CIA reporting cable indicating potential storage of chemical weapons was sent to CIA Headquarters and Desert Storm support elements in Saudi Arabia. This cable reported the location to be 3047N/04622E. The cable did not provide the name of the facility or any details about the chemical weapons, but mentioned the information corresponded to a storage area "east of Juwarin." The chain of acquisition of this report was quite tenuous. The source was reportedly in the Iranian Air Force or Air Force-related industry; he apparently passed the information through foreign intermediaries. [9] In Saudi Arabia, this report was immediately made available to Central Command (CENTCOM) and some subordinate US military elements in Riyadh. [10] Review of the cable shows the coordinates to be at or near the town of Tall al Lahm on various maps, and the storage area (unnamed) on the Joint Operations Graphic (JOG) series map to be near "Al Khamisiyah." This storage area is the Khamisiyah storage facility.

On 24 February, CIA was informed that CENTCOM/Collections tasked its assets to investigate this facility. On 25 February 1991, CIA/DO telephoned a CIA analyst and relayed some of the information in the cable. The analyst noted that the coordinates were close to the An Nasiriyah depot and Tallil airfield, both of which were carried as suspect CW storage facilities because of the presence of S-shaped bunkers. The analyst consulted with the National Photographic Interpretation Center (NPIC) and learned that CW-related activity had been reported at An Nasiriyah in mid-January 1991. On the basis of this activity, the analyst suspected that the report referred to the An Nasiriyah depot.<sup>8</sup> [11] Nevertheless, this misidentifi-

<sup>8</sup> Later information suggests that An Nasiriyah actually was a CW storage facility at the beginning of Desert Storm. According to Iraqi declarations, the undamaged mustard rounds stored in the open near Khamisiyah were moved there from Nasiriyah after the air war began.

cation was never relayed to DoD. Instead, CIA indicated that "WE ARE UNABLE TO IDENTIFY SPECIFIC CHEMICAL STORAGE FACILITY AT [referenced] LOCATION." [12] The second paragraph of the 23 February 1991 cable was subsequently sent to select CIA analysts.

During 23-25 February 1991, Army Central Command (ARCENT) issued a collection emphasis for the coordinates mentioned in the 23 February CIA cable; this emphasis, however, requested confirmation that Iraqi troops were present and did not mention chemical weapons. [13] In addition, it is unclear if there is any direct relationship between this information and a 26 February 1991 XVIII Airborne Corps log entry stating that there were "possible chemicals on Objective Gold," a location at or near Tall al Lahm.<sup>9</sup> [14]

Also in February 1991, DIA completed a review of nonrefrigerated "12-frame" bunkers. (Just as the previously mentioned S-shaped bunkers were associated with the storage of chemical weapons, 12-frame bunkers were believed to be potential storage sites for biological and possibly chemical weapons.) In late February, DIA notified CENTCOM that such bunkers were at Tall al Lahm and at five other facilities. [15]

On 28 February 1991, CENTCOM's National Military Intelligence Support Team (NMIST) requested that ARCENT determine by 4 March whether chemical or biological weapons were present at 17 suspected CBW storage locations occupied by ground forces. The request stated that "THESE SITES WERE SUSPECTED TO HAVE POSSIBLY CONTAINED SPECIAL MUNITIONS PRIOR TO THE GROUND WAR." The Tall al Lahm depot and the adjacent reverted storage area were included in this list. [8] A response from VII Corps on 1 April states that no chemical weapons were found at either part of Tall al Lahm or at 11 other sites on the list occupied by US troops. Four of the facilities were not occupied by US troops and could not be surveyed.<sup>10</sup> [16]

<sup>9</sup> This paragraph was prepared in coordination with DoD's Office of the Special Assistant for Gulf War Illnesses.

<sup>10</sup> This paragraph was prepared in coordination with DoD's Office of the Special Assistant for Gulf War Illnesses.

### The Postwar Period: March-April 1991

Postwar reports received by the IC indicated that no chemical weapons were found in the Kuwaiti Theater of Operations (KTO). [17] These reports were generally accepted by the IC. While most national-level sources said that Iraq's chemical munitions were probably not marked, lower-level tactical units were disseminating information on markings that was gathered from enemy prisoner of war (EPW) interrogations and other local sources. [17] As a result, either the standard US CW marking system or incorrect markings data gleaned from EPWs were mistakenly used by some CENTCOM troops as the basis for determining if captured Iraqi munitions contained chemical agents. On 6 March 1991, in an attempt to gain clearance to enter the KTO, CIA analysts relayed concerns about the markings issue to CENTCOM J-2 and J-3 officers in Saudi Arabia through the Joint Intelligence Liaison Element in Saudi Arabia (JILE/Saudi):

ALTHOUGH THERE HAVE BEEN EPW REPORTS THAT IRAQ'S CHEMICAL MUNITIONS HAVE COLORED BANDS [or] OTHER MEANS OF IDENTIFICATION, OUR EXPERIENCE WITH THE MUNITIONS IRAQ USED IN ITS WAR WITH IRAN INDICATES THAT THE IRAQIS DID NOT/MARK THEIR CHEMICALLY FILLED MUNITIONS. WE BELIEVE THE EPW REPORTS ON MARKINGS MAY REFLECT TRAINING CLASSES ON CHEMICAL MUNITIONS USING SOVIET EXAMPLES...IF PERSONNEL IN THE KTO ARE NOT AWARE OF THIS POSSIBILITY, OPPORTUNITIES TO SUCCESSFULLY IDENTIFY CHEMICALLY FILLED MUNITIONS MAY BE MISSED. WHEN CACHES OF UNMARKED MUNITIONS ARE DESTROYED, THERE IS ALSO THE POSSIBILITY THAT INDIVIDUALS COULD BE EXPOSED TO CHEMICAL WARFARE AGENTS. [18]

Although not known to analysts at the time, US forces had destroyed Bunker 73 at Khamisiyah two days earlier.

As reported by UNSCOM inspectors, the Iraqi chemical weapons inadvertently demolished by US troops at Khamisiyah had no CW-specific marking or colored bands. Furthermore, Iraqi munitions at Khamisiyah that did bear colored markings—as seen on US military photography—can be readily identified as non-CW munitions.

In April 1991, the United States intercepted an Iraqi report that claimed American forces blew up the Khamisiyah depot on 1 and 2 April 1991. [19] In fact, according to DoD, US forces had demolished the majority of the facility during 4-10 March 1991, although additional demolition continued to occur until US forces withdrew in mid-April. Additional reporting, distributed widely within the IC, indicated that Khamisiyah was later surveyed by Iraqi forces seeking to salvage usable munitions. This reporting indicated that the Iraqis believed "MOST OF THE AL KAMISIYAH [sic] AMMUNITION DEPOTS WERE DESTROYED BY 'AMERICAN' AIRCRAFT BOMBING OR DETONATION . . ." [20] None of this reporting mentioned the presence of chemical weapons, however, and they were not reviewed by CW analysts.

### Supporting UNSCOM: May 1991-93

The first indication that damaged chemical munitions were located at Khamisiyah appeared in Iraq's 16 May 1991 declaration to the United Nations. In that declaration, Baghdad listed 2,160 destroyed sarin-filled 122-mm rockets at "Khamisiyah stores" and 6,240 intact mustard-filled 155-mm artillery shells at "Khamisiyah stores (Nasiriyah)." [21] Because of the previous assessment that An Nasiriyah was a suspect CW storage facility, the IC assumed at the time that this was the facility Iraq was referring to, and that what the Iraqis called Khamisiyah, we called An Nasiriyah. A follow-up Iraqi declaration from 17 May reported that "Khamisiyah stores (Nasiriyah)" was located at 3046N/04630E.<sup>11</sup> These declarations to the

UN were obtained through the Department of State and were given broad distribution throughout State, DoD, and the IC.

In August 1991, CIA published a highly classified intelligence assessment on Iraqi noncompliance with UN Security Council Resolution 687, which mandated the elimination of Iraq's chemical, biological, and nuclear weapons and ballistic missile programs. This report, which received limited distribution within the intelligence and policy communities,<sup>12</sup> compared Iraq's grossly inadequate declarations with what we knew about its programs to develop weapons of mass destruction. Khamisiyah was listed in this document as a known CW storage site:

*We know . . . that chemical weapons have been stored at three declared sites—Samarra', Muhammadiyat, and Khamisiyah—for several years . . . Chemical weapons were stored at the Khamisiyah site as early as 1985 . . . Iraq declared that chemical munitions are stored at the Khamisiyah storage facility, near the city of An Nasiriyah...reporting indicated in 1986 that several thousand mustard munitions were stored at the Khamisiyah site. The Iraqi coordinates are*

<sup>11</sup> These coordinates fall near—but not directly on—the Khamisiyah depot. The geographic coordinates declared by the Iraqis for other CW sites known to us were in error by as much as 30 minutes (about 50 kilometers), however, so the accuracy of declared coordinates was questionable. As a result, the declared coordinates were viewed by the IC as consistent with the An Nasiriyah depot. In addition, the Iraqis were less than forthcoming and sometimes misleading in this and other declarations, which tended to bring to question the overall credibility of Iraqi information.

<sup>12</sup> External distribution:

The President  
Assistant to the President for National Security Affairs  
Assistant to the President and Deputy for National Security Affairs  
The Secretary of State  
The Secretary of Defense  
The Secretary of Energy  
Chairman, Joint Chiefs of Staff  
The Director, Defense Intelligence Agency  
The Director, National Security Agency  
The Director, Arms Control and Disarmament Agency  
Assistant Secretary of State for Intelligence and Research  
Assistant Chief of Staff of Air Force Intelligence



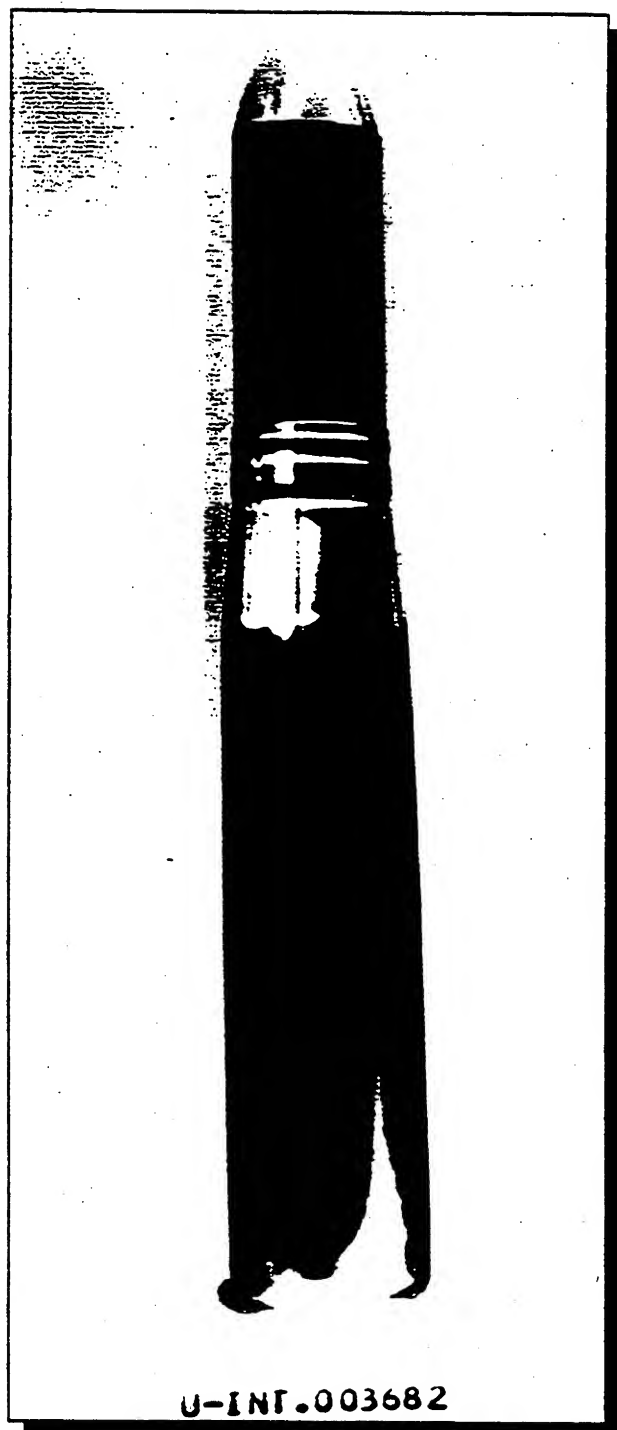


Figure 4. Some Iraqi munitions at Khamisiyah—such as this high-explosive squash head (HESH) round—had colored markings but were readily identified as non-CW munitions.

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close to those of a storage facility near An Nasiriyah that contains one S-shaped bunker. The bunker was extensively damaged by Coalition attacks. [Emphasis added.] [22]

While drafting this paper, CIA analysts reviewed the May 1986 report. At that time, they interpreted Khamisiyah to be An Nasiriyah in light of the wording in Iraq's May 1991 declaration, as well as the analytical emphasis placed on S-shaped bunkers. In addition, the quote cited above contains several inaccuracies:

- We *knew* that chemical weapons had been stored at Samarra and Muhammadiyat *for several years*; that part of the August 1991 paper was correct. However, we did *not know*—and still do not have evidence—that chemical weapons had been stored at Khamisiyah or Nasiriyah *for several years*. At the time the paper was written, we *knew* that chemical weapons had been stored at a site named Khamisiyah during 1984 and 1985, and we had known that *for several years*.
- The negation date of 1985 was inaccurate: the May 1986 report—from which this quote was extracted—clearly indicated that chemical weapons were moved to Khamisiyah in June 1984.

On the Khamisiyah issue, in short, this paper not only perpetuated the erroneous connection with An Nasiriyah, but it also generated some additional inaccuracies. [22]

During the UNSCOM 9 (CW 2) inspection from 15 to 22 August 1991, Iraq stated that Coalition troops still occupied Khamisiyah on 18 April 1991—the date of Iraq's first declaration—and that Iraq was unable to account for the chemical weapons stored there until after Coalition forces departed. This information was first obtained by the US Government in September 1991 but was not widely available until June 1992. [23]

The US Government continued to confuse Khamisiyah with Nasiriyah until after October 1991, when UNSCOM 20 inspected Khamisiyah and





Figure 5. Demolition of bunkers at Khamisiyah. 4 March 1991.

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documented the location and disposition of chemical weapons at the site.<sup>13</sup> [24] Continuing to bolster the erroneous connection between An Nasiriyah and Khamisiyah, a DIA analyst using an IC presentation briefed the UNSCOM 20 team on An Nasiriyah before the inspection, believing this to be the site Iraq called Khamisiyah. The Arms Control Intelligence Staff (ACIS)<sup>14</sup> later determined—on the basis of a description of the facility and better locational information obtained through Global Positioning Satellite (GPS) receivers—that Khamisiyah was actually the facility known to the United States as Tall al Lahm. [25, 26]

The Iraqis claimed that Coalition forces had destroyed buildings and munitions at Khamisiyah. At the time, many analysts believed that the chemical weapons

found at Khamisiyah might have been placed there after the ground war as part of the Iraqi effort to conceal aspects of its weapons-of-mass-destruction programs. In hindsight, the April 1991 intercept of similar information mentioned earlier should have added credibility to the Iraqi claim and should have led the US Government to conclude much sooner that Khamisiyah was a potential CW release site. The IC requested DIA review available imagery of the facility for preinspection activity that would suggest that the Iraqis staged the inspection. However, no images immediately prior to the inspection were available. That review covered only a short period prior to the inspection and did not extend to a review of intelligence that included the 18 August 1990 information described earlier.

On 12 November 1991, DoD disseminated a report drafted by ACIS, which included Iraq's claims about Coalition destruction of chemical munitions and offered some supporting evidence:

**THE IRAQIS CLAIMED THE BUILDINGS AND MUNITIONS WERE DESTROYED BY OCCUPYING COALITION FORCES. IN**

<sup>13</sup> Additional information about Khamisiyah was obtained by two UNSCOM inspection teams later in 1991, but this information was not passed to the United States until after information from the UNSCOM 20 inspection. During the UNSCOM 11 (August 1991) inspection, the correct coordinates of Khamisiyah were acquired by UNSCOM from the Iraqis. UNSCOM 17 became the first inspection team at Khamisiyah when it very briefly visited the site on 25 October 1991.

<sup>14</sup> ACIS is an interagency organization that, at the time, was the IC focal point supporting US Government efforts vis-a-vis Iraq.

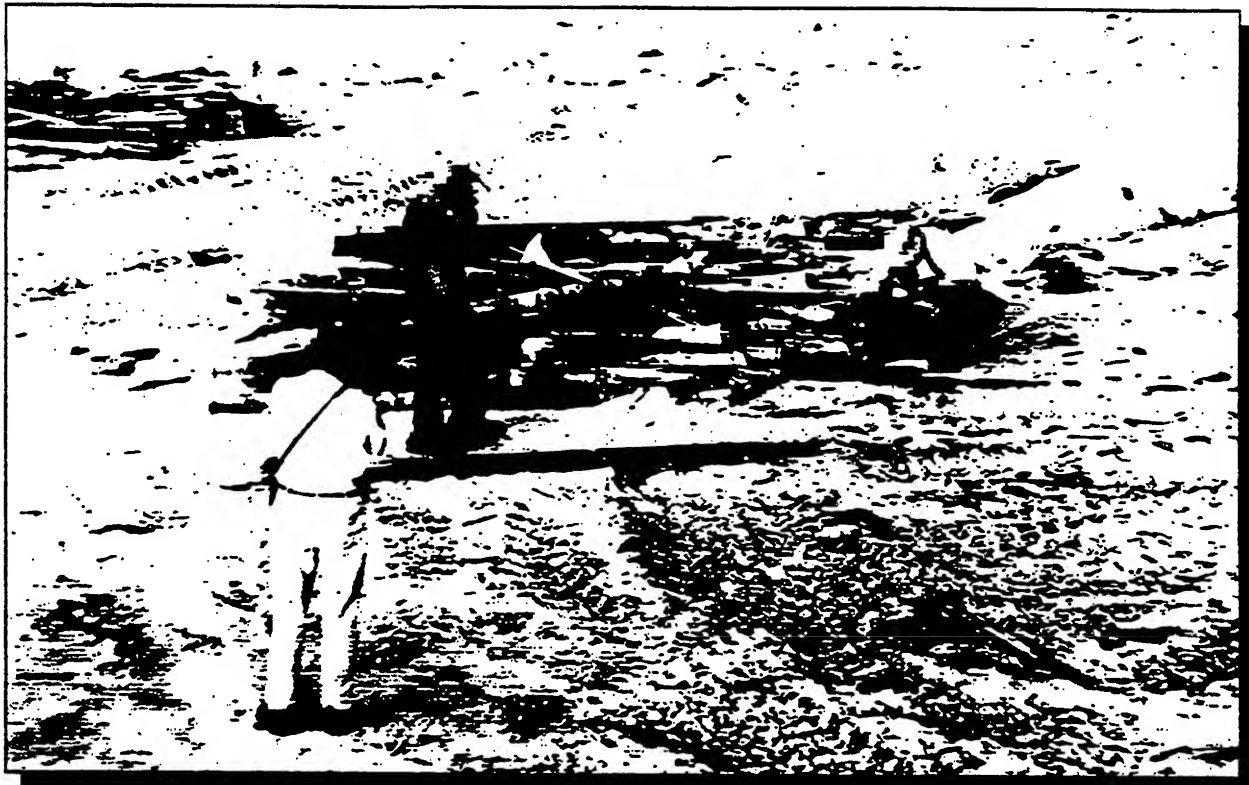


Figure 6. United Nations inspection, October 1991.

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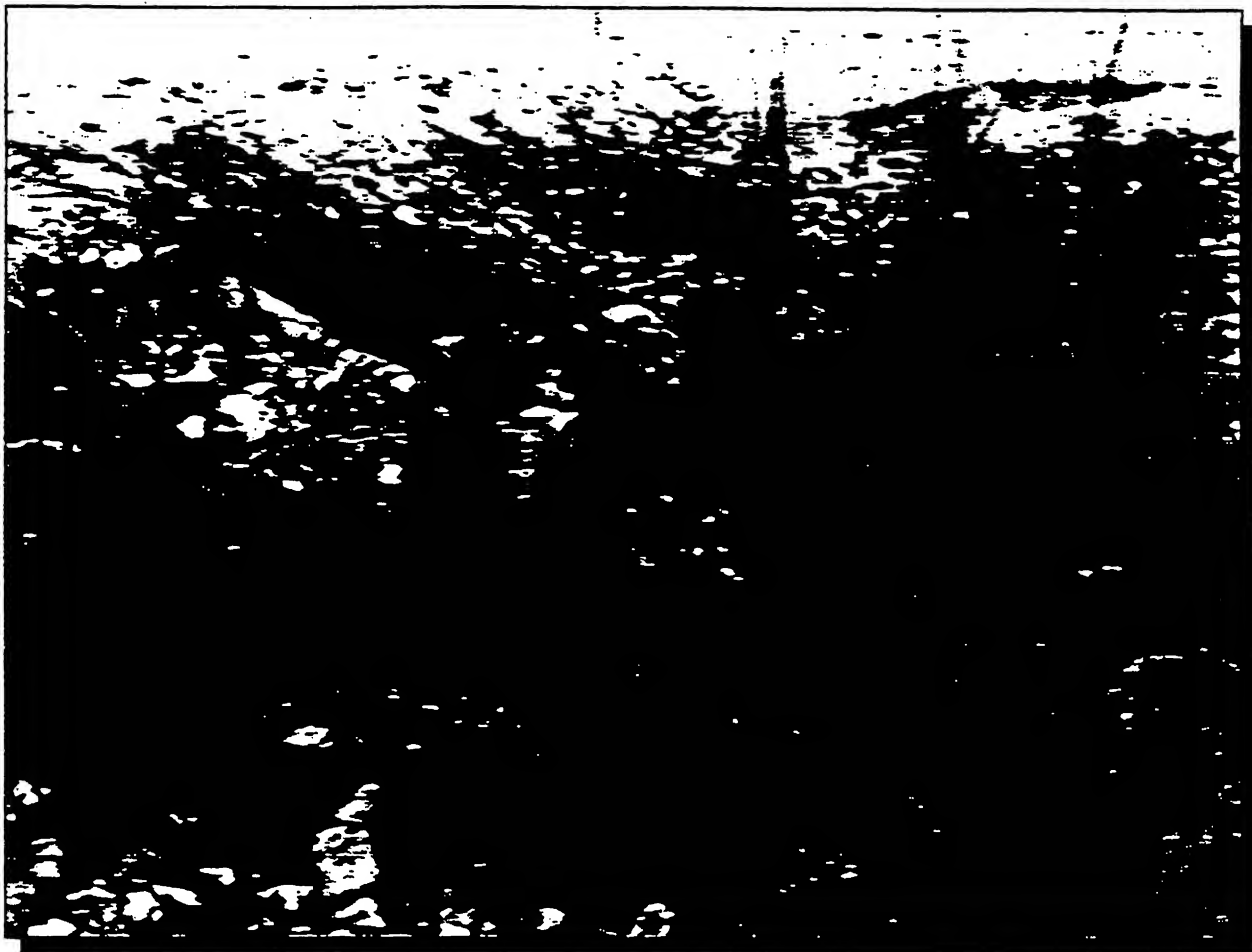
THE TEAM'S ESTIMATION, THE DESTRUCTION OCCURRED AS A RESULT OF LOCALLY-PLACED EXPLOSIVES AS OPPOSED TO BOMBING. [27]

The report was widely disseminated, including to DoD. The same day, additional information suggesting that US forces conducted demolition activities in the areas inspected by UNSCOM 20 appeared in an internal ACIS administrative cable, which was not distributed outside CIA:

THE INSPECTORS ALSO NOTED THAT THE BUILDINGS [at Khamisiyah] WERE DESTROYED BY DEMOLITIONS AS OPPOSED TO AERIAL BOMBARDMENT. THEY ALSO FOUND AN EMPTY U.S. CRATE LABELED AS M48, WHICH ARE SHAPE CHARGES USED BY THE U.S. MILITARY. [We] NOTIFIED ARMY CENTRAL COMMAND (ARCENT) [G-2 Forward in

Dhahran] OF THE LOCATION AND EVIDENCE FOUND AT TALL AL LAHM. WE RECEIVED INFORMATION FROM ARCENT TO THE FACT THAT 24TH MECHANIZED INFANTRY DIVISION WAS LOCATED IN THE VICINITY OF TALL AL LAHM. BUT WE ARE UNABLE TO CONFIRM IF U.S. TROOPS DID IN FACT DESTROY BUILDINGS AT THIS PARTICULAR SITE. WE ARE SENDING THIS INFORMATION TO YOU IN ORDER TO TAKE APPROPRIATE ACTION AS YOU SEE FIT AS THE RISK OF CHEMICAL CONTAMINATION BY 24TH ID PERSONNEL IS A POSSIBILITY. [28]

Internal documents show that ACIS contacted an individual in the office of the G-2, 24th Mechanized Infantry Division, on 20 November 1991. [29, 30]



*Figure 7. Remnants of Bunker 73 at Khamisiyah, February/March 1992.*

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Subsequent information identified by DoD's Office of the Special Assistant for Gulf War Illnesses indicates that G-2 asked G-3 whether the 24th found chemical weapons, or was at Khamisiyah. ACIS did not pursue this issue with JCS, DIA, or OSD at that time. We have seen no evidence yet that ARCENT included the findings in reports to higher authorities.

The UNSCOM 29 inspection in February and March 1992 involved the destruction of hundreds of chemical munitions at Khamisiyah. During the inspection, the Iraqis repeated their claim that Coalition forces destroyed chemical munitions in 1991. [31] After

leaving Iraq, one of the UNSCOM team members informally requested additional background information before further destruction activities at Khamisiyah. This involved details pertaining to Coalition force activities at Khamisiyah: who was there, when they were there, and what actions were taken. [32] UNSCOM never made a formal request for this information and never followed up on the informal request, perhaps because UNSCOM decided no further destruction activity at Khamisiyah was necessary.

In February 1996, CIA began a search for documents relating to the Khamisiyah facility as a possible chemical agent release site in 1991. Early in that search, an undated working paper was found in an Iraqi chemical weapons inspections file in the Nonproliferation Center (NPC).<sup>15</sup> Further queries indicated that an NPC officer drafted the working paper in May 1992, intending it to be included with a formal action requirement to DoD after determining that no action had been taken on the earlier informal request. [33] In the paper he suggests the possibility that US forces unwittingly destroyed CW munitions at Khamisiyah. He does not recall taking any further action on the draft, and he did not maintain a copy in his personal files. [34] CIA cannot find any record of it being attached to a tasking, distributed within NPC or CIA, or sent to the IC or DoD. It is possible that no further action was taken because the issue of the presence of Coalition forces at Khamisiyah had already been raised with DoD in November 1991. In addition, as stated earlier, UNSCOM had decided that no further destruction at Khamisiyah was necessary, and the IC continued to focus on the large portions of Iraq's CW program that Baghdad had hidden.

#### **Gulf War Illnesses Concerns: 1993-Present**

From 1993 through mid-1995, CIA efforts focused on providing intelligence support to DoD investigations, since most of DoD's efforts involved operational issues.

During a Senate Banking Committee hearing on 25 May 1994, Senator Don Riegle focused on the issue of potential CW agent fallout from bombed Iraqi facilities, including the "An Nasiriyah" depot. The Director of NPC addressed the issue of chemical weapons in the KTO:

The coalition forces did not find any CW agents stored in the Kuwaiti theater of operations, with the exception of some the UN found near An Nasiriyah.

<sup>15</sup> In December 1991, NPC took over the former ACIS role of IC focal point supporting US Government efforts vis-a-vis Iraq.

This reference to An Nasiriyah, and others made by DoD officials at the hearing, demonstrate that there was still some confusion at the time about where chemical weapons were found in the KTO. [35]

In August 1994, DIA responded to a series of questions related to Gulf war illnesses that were posed by the Senate Banking Committee. Distrust of Iraq and continuing confusion surrounding Khamisiyah are reflected in DIA's response on the issue of chemical weapons in the KTO:

Finally, it has been widely circulated that UN inspection teams found thousands of destroyed and intact chemical rounds in an ammunition depot at Nasiriyah, and that this discovery contradicts our statement in paragraph one of this answer. Nasiriyah technically is outside the KTO, being north of 31°00 N and the Euphrates River. More importantly, it was not in the territory occupied by Coalition forces after the war. Moreover, the following points are relevant because UN inspectors did not really "find" the subject munitions. In reality, the Iraqis declared the munitions to the UN and the inspectors eventually went to that location to check what the Iraqis had reported:

- 1) The UN inspection occurred at least eight months after the war;
- 2) The location of the "found" chemical rounds was 15 miles from the widely discussed CBW bunkers bombed at Nasiriyah (the site which was originally expected to be inspected). The bombed bunkers were not inspected until one year later in Oct 1992 and found to contain no chemical or biological weapons ... [36]

Because of the increased focus on Gulf war illness issues by both the public and Congress, as well as concerns raised by two CIA analysts, Acting Director of Central Intelligence Studeman authorized a

comprehensive review of intelligence by CIA on the issues related to the Gulf war in March 1995. Throughout the summer of 1995, CIA conducted a study to evaluate the possibility that US forces could have been exposed to fallout from US bombing of Iraqi CW production and storage facilities. As part of this study, a CIA analyst constructed a comprehensive summary of Iraqi CW-related facilities, focusing on the status and disposition of CW agents at these sites. Separately, an NPC officer reviewed UNSCOM information. The Khamisiyah facility emerged as a key site that needed to be investigated because of its proximity to Coalition forces and the ambiguities surrounding the disposition of chemical weapons at the site. [37] CIA informed DoD's Persian Gulf Investigative Team (PGIT)<sup>16</sup> in September 1995 of Khamisiyah's importance and requested additional information about US troop activities there to which PGIT responded in October. [38, 39]

CIA's research of Khamisiyah intensified in 1996 as evidence of unwitting US involvement in CW-related destruction activities began to be recognized. On 26 January 1996, as part of a preliminary briefing to National Security Council staff on CIA's declassification initiative and ongoing study about potential exposure to chemical, biological, and radiological agents during the Gulf war, CIA mentioned the possibility of CW storage and agent release at the Khamisiyah facility. [40] NSC Staff indicated that this needed to be pursued aggressively together with DoD. Between 8 February and 7 March 1996, analysts conducted an intensive search of historical files, imagery, and other records, uncovering more evidence linking US troops to destruction of chemical weapons at Bunker 73 at Khamisiyah. A retrospective search of imagery, for example, revealed that a row of bunkers at Khamisiyah had been destroyed between 1 and 8 March 1991—after the cease-fire. Analysts also uncovered cables indicating UNSCOM inspectors had found evidence of US demolition charges at Khamisiyah. [28] On 5 March 1996, CIA informed a Presidential Advisory Committee (PAC) staffer that a probable release of chemical agent occurred at Khamisiyah in conjunction with US troops. On 10 March 1996, a CIA analyst heard a tape recording of a radio show in which a veteran of the

37th Engineering Battalion described demolition activities at a facility the analyst immediately recognized as Khamisiyah. PGIT was informed on 11 March, and the PAC was notified the same week.

CIA and DoD personnel met with UNSCOM officials on 19 March 1996 to begin a dialogue regarding Gulf war illnesses issues. At this meeting, UNSCOM indicated that it planned to revisit Khamisiyah to resolve newly raised munitions accounting issues. As a result of this dialogue, UNSCOM agreed to make public appropriate relevant information. At the 1 May 1996 PAC meeting, CIA publicly announced that the 37th Engineering Battalion had destroyed munitions at Khamisiyah in March 1991 and that CIA was "working with the DoD Investigative Team to resolve whether sarin-filled rockets were destroyed at Bunker 73 and whether some US personnel could have been exposed to chemical agent."

During UNSCOM's inspection of Khamisiyah on 14 May 1996, it was determined that some of the destroyed rockets in Bunker 73 were chemical weapons. This was based on the presence of high-density polyethylene inserts, burster tubes, fill plugs, and other features characteristic of chemical warheads for Iraqi 122-mm rockets. In addition, Iraq claimed for the first time that Coalition troops also destroyed the rockets in the nearby pit area at Khamisiyah. [41] In light of this information, CIA and DoD determined that US forces destroyed chemical weapons in Bunker 73 on 4 March 1991 along with more than 30 bunkers containing conventional weapons. DoD publicly announced these conclusions on 21 June 1996. CIA efforts since then have focused on modeling the effects of agent releases at the bunker and on investigating the pit area demolition.

By August 1996, CIA had completed its study of potential exposure caused by US bombing of Iraqi chemical facilities and by the demolition of Bunker 73 at Khamisiyah. The results were made available to the public. Several critical data points necessary for a more accurate estimate of the potential chemical hazard resulting from demolitions in the pit, however, were not available. The details surrounding

<sup>16</sup> Established in June 1995.

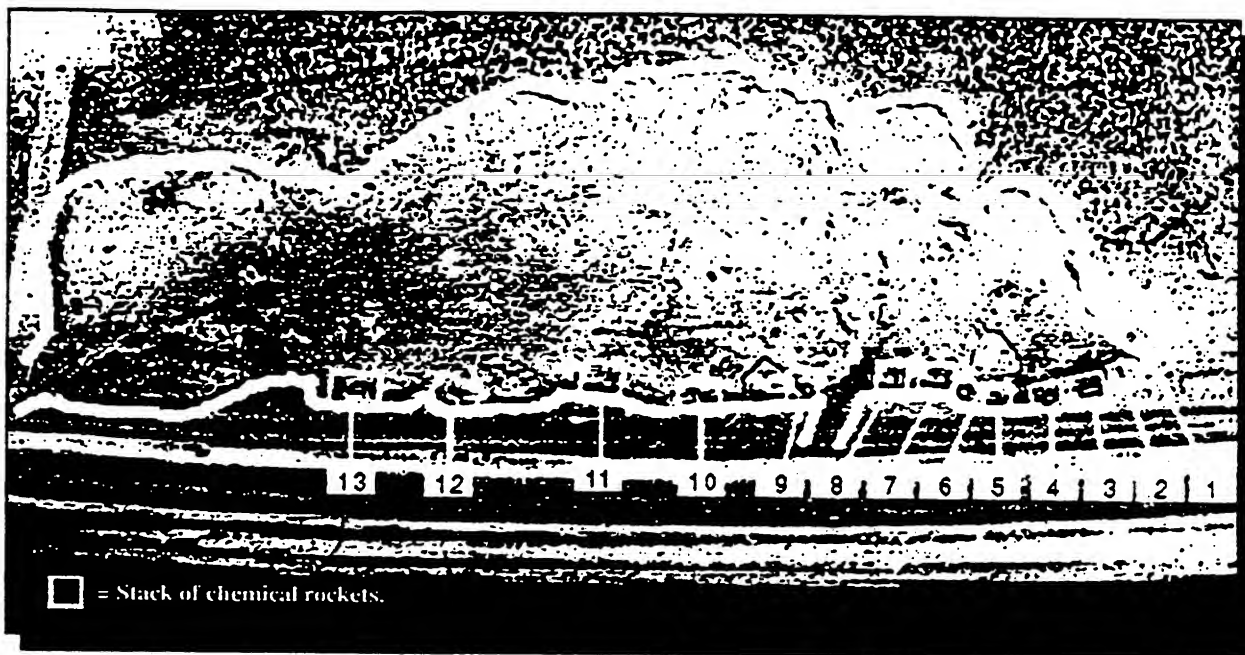


Figure 8. Predemolition photo of pit area near Khamisiyah.

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destruction of chemical weapons in the pit area are less certain than events at Bunker 73. Recent analysis of the evidence suggests that two destruction events at the pit—the first on 10 March 1991 and the second on 12 March—are more likely than a single event.

Ongoing investigations related to Gulf war illnesses have shed light on the sequence of events at Khamisiyah. DoD—including DIA and the Defense Humint Service (DHS)—and CIA have recently acquired several pieces of information. UNSCOM has made available selected videotapes, photographs, and sample analysis taken from destroyed munitions from the UNSCOM 20 inspection in 1991. In addition, we have spoken with two of the soldiers who performed demolition activity in the pit area. These data strongly suggest that munitions in the pit were destroyed by US troops and provide evidence that demolition might have occurred on two separate occasions.<sup>17</sup>

<sup>17</sup> DIA searched for tactical imagery of Khamisiyah taken after the demolition but found none; this imagery was not systematically archived. The Army IG acquired a ground photograph that, upon analysis, appears to have been taken in the pit after demolition. This is only the third known photo of Khamisiyah taken immediately after the demolition. It has already been released publicly and, in fact, has been used on flyers written by CIA and DoD to provide and seek more information on Khamisiyah.

### Efforts To Help Address Gulf War Illnesses Issues

Several IC task forces have been created since the initial DoD emphasis in 1994 on identifying intelligence information that may be related to Gulf war illnesses. DIA formed a search and declassification effort in March 1995, followed in October 1995 by CIA's Persian Gulf War Illnesses Task Force. These groups were tasked with identifying, declassifying, and publicly releasing intelligence information that might shed light on potential causes of Gulf war illnesses. In October 1996, DIA formed a Persian Gulf Focus Group to support Gulf war illness-related efforts in other DoD offices and CIA. Most recently, on 27 February 1997, Acting DCI George Tenet created an IC task force on Persian Gulf war illnesses in parallel with President Clinton's 60-day directive to the Presidential Advisory Committee. One of the purposes of this task force, which began its work on 3 March, is to ensure all documentation relevant to Khamisiyah and Gulf war illnesses is made available promptly to the many governmentwide offices now involved in the issues.



Figure 9. Chemical rockets destroyed in pit area. March 1991.

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### Some Lessons Learned

Even though CENTCOM listed the Khamisiyah facility as a potential CW storage site before the ground war, and additional concerns about the facility were transmitted in February 1991, this historical perspective highlights several areas that need attention:

- *Intelligence agencies must reconcile information in databases to eliminate confusion about facilities.* For example, different agencies' information on munition storage sites needs to be analyzed to generate a common list. This would minimize the type of confusion and misconnections made on the Khamisiyah issue and may have prompted an earlier review of older intelligence for evidence of possible CW storage or transfer activities.
- *Intelligence components handling sensitive information must review their procedures for deciding how to share vital information with others who have a need to know.* For example, intelligence analysts in Washington were not told that the original source of the 23 February 1991 report was someone in the Iranian Air Force or Air Force-related industry. [50] This cable and others related to subsequent UN inspections were not shared with DIA.
- *Intelligence analysts must remain increasingly careful to avoid "tunnel vision" in crafting their judgments.* The culture during the late 1980s stressed making definitive judgments and eschewed alternative outcomes or analysis. The IC in recent years has

made important strides in addressing these problems, including changing its culture and instituting analyst training programs to stress inclusion of alternative scenarios and conclusions.

- *Finally, as intelligence agencies support defense and policy efforts on specific issues, they must ensure that searches are more thorough in order to provide the fullest possible answers.* For example, a search of CW files dating back to Iraqi use of CW in the Iran-Iraq war would have revealed the 1986 Khamisiyah-Tall al Lahm connection and its association with chemical weapons, and at a minimum should have placed the facility on the IC's list of suspected CW sites for targeting and warning. It might also have prompted a more thorough search for other information.

The DCI Persian Gulf War Illnesses Task Force will be providing a paper on the lessons learned through its studies. That paper will include recommendations to address concerns discovered in this study, as well as any others discovered by the Task Force in the course of its work. In this regard, the Task Force's intent is not only to assist US Government efforts on Gulf war illnesses issues, but also to help the IC enhance its efforts for the future.



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## Chronology

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### Information & Events

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### Actions

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Sep 76: First intelligence revealing depot

Jun 77: Depot named "Tall al Lahm" in imagery database

Sep 80: Iran-Iraq war begins

Apr 82: First mention of "Khamisiyah" depot in reporting

Aug 83: Iraq begins using chemical weapons against Iran

Jul 84: Decon vehicle present at Khamisiyah; not found until March 1997

May 86: Sensitive human-source report indicates chemical weapons moved to Khamisiyah between Jun 84 and Mar 85; report received limited distribution

Nov 86: CIA/DI intelligence assessment concludes that chemical weapons stored at "Tall al Lahm," but highlights S-shaped bunkers as future CW deployment sites

2 Aug 90: Iraq invades Kuwait

18 Aug 90: Possible chemical weapons transfer activity underway at Khamisiyah, but not identified as such until early 1996

Reported as munitions transloading activity

17 Jan 91: Desert Storm air campaign begins

23 Feb 91: CIA reporting cable sent to Headquarters and Desert Storm support element states chemical weapons stored at 3047N/04622E (now known to be Khamisiyah)

Report passed to CENTCOM in Riyadh; CENTCOM issues several collection taskings that week, but relationship unclear

24 Feb 91: Ground war begins

28 Feb 91: Cease-fire declared

DIA notifies CENTCOM that possible BW- or CW-related bunker identified at Tall al Lahm

4, 10, 12 March 91: US troops destroy chemical weapons at Khamisiyah

## Chronology (continued)

Information & Events	Actions
	6 Mar 91: CIA analysts warn CENTCOM of risks from unmarked Iraqi chemical munitions; Khamisiyah not on CIA list of facilities of interest
8 Mar 91: CENTCOM reports that no chemical munitions found in KTO and restates its view that Iraqi chemical munitions bear characteristic markings	
Apr 91: Intercepted Iraqi reports claim US forces destroyed Khamisiyah on 1-2 April	
16 May 91: Iraqi declaration provides first indication that damaged chemical weapons located at "Khamisiyah storage facility"	Declared facility assessed to be An Nasiriyah
15-22 Aug 91: Iraq tells UNSCOM 9 (CW 2) team that Khamisiyah and chemical weapons there were under Coalition control until after 18 Apr 91	
Oct 91: UNSCOM 20 inspects Khamisiyah; originally expected site to be Nasiriyah	Nov 91: Khamisiyah correctly identified as facility commonly known to the US as Tall al Lahm
12 Nov 91: CIA administrative cable notes evidence of US demolition charges found at Khamisiyah	CIA notifies ARCENT; later contacts 24th Mech.
Feb-Mar 92: UNSCOM 29 destroys chemical weapons at Khamisiyah; UNSCOM informally requests information on Coalition activities at site	Memo seeking DoD answers to UNSCOM request drafted by NPC officer but apparently not sent; no formal UNSCOM request
25 May 94: CIA testimony to Senate Banking Committee shows CIA aware that "Nasiriyah" depot in KTO, but uncertain if US troops occupied site	
Mar 95: ADCI Studeman authorizes CIA review of relevant intelligence	
	Summer 95: CIA conducts study of potential exposure from bombed Iraqi CW facilities; concludes Khamisiyah key to exposure issue; requests information on US troop activities there
	26 Jan 96: CIA briefs Khamisiyah evidence to NSC
	8 Feb-7 Mar 96: Intensive CIA search of historical files uncovers more evidence linking US troops to destruction of chemical weapons at Khamisiyah

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**Chronology (continued)**

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Information & Events	Actions
10 Mar 96: CIA analyst hears taped radio broadcast that provides missing link connecting US troops to Khamisiyah demolition	DIA, PGIT. PAC quickly notified of this discovery
19 Mar 96: UNSCOM plans to revisit Khamisiyah based on concerns of Iraqi munitions accounting	1 May 96: At PAC hearing, CIA publicly announces evidence US troops unknowingly destroyed chemical weapons at Khamisiyah
14 May 96: UNSCOM inspects Khamisiyah, verifies that Bunker 73 contained chemical rockets; Iraq claims for first time that US forces destroyed chemical weapons in pit area as well	Aug 96: CIA publishes unclassified study of potential exposure caused by US bombing of various Iraqi chemical facilities and by demolition at Khamisiyah Bunker 73
	Oct 96: DIA forms Persian Gulf Focus Group; acquires additional evidence about pit area demolition
	27 Feb 97: ADCI Tenet creates IC task force on Gulf war illnesses

## References

- 1 First identification of Tall al Lahm, 1976
- 2 First indication of Khamisiyah depot, April 1982
- 3 Reported coordinates of Khamisiyah, August 1982
- 4 Report indicating chemical weapons at Khamisiyah, May 1986
- 5 Iran-Iraq: Chemical Warfare Continues, November 1986
- 6 Reported Iraqi CW storage locations, August 1988
- 7 DIA assessment of Iraqi CW storage possibilities
- 8 Military intelligence information request, 28 February 1991
- 9 CIA cable on suspected chemical storage area, 23 February 1991
- 10 CENTCOM informed of 23 February 1991 CIA cable, 24 February 1991
- 11 CIA Desert Storm CBW activity report, 25 February 1991
- 12 CIA response to 23 February 1991 cable, 26 February 1991
- 13 ARCENT collection emphasis, 25 February 1991
- 14 XVIII Corps log entry, 26 February 1991
- 15 DIA suspect BW/CW facilities cable, 28 February 1991
- 16 ARCENT response to 28 February 1991 military intelligence information request, 1 Apr 91
- 17 Cable relaying CENTCOM information on CW, 8 March 1991
- 18 CIA relays concerns about unmarked chemical munitions, 6 March 1991
- 19 Report describing US demolition of Khamisiyah, 3 April 1991
- 20 Report describing US destruction of Khamisiyah, 21 April 1991
- 21 Iraqi declaration, 16 May 1991
- 22 Iraq's Noncompliance With UN Security Council Resolution 687, August 1991

- 23 Answers to questions posed by UNSCOM 9 on chemical agents and synthetic processes
- 24 Site descriptions from UNSCOM 20 inspection report, 13 November 1991
- 25 Memorandum of phone call, 15 November 1991
- 26 ACIS on facility identification and tasking, 15 November 1991
- 27 UNSCOM 20 inspection results of Khamisiyah ammunition storage facility, 12 November 1991
- 28 Situation report on Tall al Lahm ammunition storage depot, 12 November 1991
- 29 Record of phone call, 20 November 1991
- 30 Cable version of record of phone call, 20 November 1991
- 31 Chemical rocket destruction in Khamisiyah, 1992
- 32 UNSCOM member questions about Coalition activity, 1 April 1992
- 33 Working paper mentioning possible CW exposure, 1992
- 34 Internal memorandum on Persian Gulf war veterans' illnesses, 30 May 1995
- 35 Hearing before the Committee on Banking, Housing, and Urban Affairs; United States Senate; 103rd Congress; 2nd Session, 25 May 1994
- 36 DIA response to Riegle Committee questions, August 1994
- 37 Internal memorandum describing uncertainties about Tall al Lahm, 6 September 1995
- 38 Internal memorandum requesting information to support study of potential exposure issues, 13 September 1995
- 39 Unit location listing provided by PGIT
- 40 CIA briefing to NSC on study of potential exposures, 26 January 1996
- 41 Iraqi Fallujah, Khamisiyah, and An-Nasiriyah chemical warfare related sites, 1996

# Case Narrative

## *Khamisiyah*

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on the actions of American troops at Khamisiyah. In addition, we report on when it became known that American troops may have been exposed to chemical agents there. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding Khamisiyah. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

THIS IS AN INTERIM REPORT,  
NOT A FINAL REPORT

## U.S. DEMOLITION OPERATIONS AT THE KHAMISIYAH AMMUNITION STORAGE POINT

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on the actions of American troops at Khamisiyah. In addition, we report on when it became known that American troops may have been exposed to chemical agents there. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding Khamisiyah. Please contact my office to report any new information by calling:

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Last Update: February 21, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1995 to investigate all possible causes. On 12 November 1996, responsibility for these investigations was assumed by the Investigation and Analysis Directorate (IAD), Office of the Special Assistant for Gulf War Illnesses (OSAGWI) which has continued to investigate the events that occurred at Khamisiyah. Its interim report is contained here. In addition, the Army Inspector General was directed by the Secretary of the Army on 25 September 1996 to conduct an investigation into Army operations at Khamisiyah, and the Assistant to the Secretary of Defense for Intelligence Oversight was directed by the Deputy Secretary of Defense on 25 September 1996 to review what the intelligence communities knew concerning Khamisiyah. These independent efforts have not yet been completed and may shed additional light on events at Khamisiyah.

As part of the effort to inform the public about the progress of this effort, DoD is publishing on the Internet and elsewhere accounts related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling the account. The narrative that follows is the first such account.

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## **SUMMARY**

The story of the Khamisiyah Ammunition Storage Point or ASP has three parts: the efforts of U.S. forces to destroy Khamisiyah, the inspection of the site by the United Nations Special Commission or UNSCOM, and the public inquiry into the events that occurred there, "what we knew, and when we knew it:"

### **The Destruction of Khamisiyah**

Immediately following the end of Operation Desert Storm, U.S. Army units occupied the area known as Objective GOLD and later identified as the Khamisiyah ASP (which was also known as Tall al Lahm or Suq Ash Shuyukh). Khamisiyah was a huge ammunition storage site, covering 50 square kilometers and containing about 100 ammunition bunkers and several other types of storage facilities. The XVIII Corps (Airborne) (ABN) dispatched combat engineer and demolition units to Khamisiyah to destroy its munitions and facilities.

To perform the demolition, U.S. forces set off two very large explosions, one on 4 March 1991 and a second on 10 March 1991. They also set off a number of smaller explosions to destroy small caches of munitions and to test techniques for destroying bunkers. Demolition operations continued in the Khamisiyah area through most of April 1991.

During the demolition operations, and, indeed, throughout the entire period of U.S. occupation at Khamisiyah, there were no reports of verified chemical agent detections, nor were there reports of anyone, soldier or civilian, experiencing symptoms consistent with exposure to a chemical agent.

### **Inspecting Khamisiyah**

In October 1991 and March 1992, and then again in May 1996, the UNSCOM inspected Khamisiyah, specifically searching for chemical weapons. Based on their own inspections and information provided by the Iraqis, UNSCOM inspectors identified three sites in and around Khamisiyah that had contained chemical weapons: in an area that became known as the "pit;" in Bunker 73, one of the bunkers subsequently identified as having been blown up by U.S. troops; and in an above-ground storage area.

In October 1991, UNSCOM inspectors found about 300 damaged and intact 122mm rockets in an area surrounded by a berm southeast of the main ASP. This area became known as the "pit." Their investigation showed that the intact rockets contained chemical agents (sarin and cyclosarin). During a subsequent visit in March 1992, about 500 rockets were blown up on site near the "pit", with the remaining rockets being shipped to Al Muthanna, Iraq for subsequent destruction. The UNSCOM destruction efforts accounts for 782 rockets; the Iraqis report that 2,160 such rockets had been at Khamisiyah. It is unknown how many of the unaccounted for rockets were destroyed by U.S. forces.

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During the 1991 inspection, the Iraqis claimed that chemical munitions found in the "pit" had been salvaged from Bunker 73 and that both had been destroyed by Coalition Forces. UNSCOM inspectors visited the site of the bunker, which appeared damaged, and used chemical agent monitors. These monitors were negative, and the inspectors did not thoroughly search the bunker.

The UNSCOM team was also shown an above-ground storage site about 3 kilometers west of the ASP containing 6,300 intact 155mm artillery shells filled with mustard agent. To date, there is no evidence that any Coalition Forces had been to this site. These rounds were also shipped to the destruction facility at Al Muthanna.

US intelligence became aware of the UNSCOM findings in November 1991, but at the time this report did not result in identification of which, if any, U.S. troops participated in demolition activities at Khamisiyah. The lack of contemporaneous U.S. reports of chemical weapons, and the fact that the Iraqis were selective in their willingness to cooperate, as reported by UNSCOM to the United Nations Security Council, led to the belief the Iraqis were not telling the truth about chemical weapons being at the site when the demolition occurred. In May 1996, UNSCOM again returned to Khamisiyah, where the team conclusively identified debris in the rubble of Bunker 73 that was characteristic of chemical munitions.

### **The Public Inquiry**

In February 1994, a request from Congressman Browder to the UN for any reports about chemical weapons found in Iraq after the Gulf War rekindled U.S. interest in Khamisiyah. The UN responded with a letter in April 1994 which listed Khamisiyah along with other chemical weapons sites. During hearings on export administration in May 1994 before the Senate Banking, Housing and Urban Affairs Committee, DoD witnesses admitted the UN had found chemical weapons at Khamisiyah but were unable to confirm that any U.S. troops were at the site.

In March 1995, as a result of Presidential concerns, the CIA began a reexamination of relevant intelligence. In May 1995, a Presidential Advisory Committee (PAC) was created. In June 1995, DoD formed the Persian Gulf Illnesses Investigation Team (PGIIT). Throughout 1995 and 1996, interest in Khamisiyah and the events surrounding it increased. On June 21, 1996, DoD confirmed publicly that "U.S. soldiers from the 37th Engineer Battalion destroyed ammunition bunkers at [Khamisiyah] in early March 1991 ... it now appears that one of these destroyed bunkers contained chemical weapons."

DoD investigation into the subject continues. What follows provides additional detail about the events described in this summary. The information upon which this narrative is based is incomplete. As the investigation continues, the IAD hopes to answer a number of these questions, including the following:

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- How many chemical warfare munitions were present at Bunker 73 and at the "pit" at the time the U.S. demolitions took place?
- Were two separate groups working in the "pit" on 10 March 1991?
- Was there an additional demolition of munitions at the "pit" on 12 March 1991?
- Who were the 15 to 20 engineers assigned to assist the EOD noncommissioned officer in the "pit" on 10 or 12 March 1991?
- What were the weather conditions on the day(s) of the "pit" demolition(s)?

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## NARRATIVE (An acronym listing/glossary is at Tab A)

### Introduction

The Khamisiyah ASP, also known to Coalition Forces as Tall al Lahm, Suq Ash Shuyukh (local Iraqi place names), or Objective GOLD,<sup>1</sup> was a large munitions storage depot. It is located in southern Iraq along the southern side of the Euphrates River and about 25 kilometers southeast of the city of An Nasiriyah. The ASP area borders a major highway<sup>2</sup> used extensively by U.S. troops transiting the area after the cease-fire began. Khamisiyah was an extensive complex of above- and below-ground ammunition bunkers, general storage buildings, and open equipment storage revetments (sand mounds, or berms) covering approximately 50 square kilometers. The main site covered 25 square kilometers. Figure 1 shows the location of Khamisiyah in the Kuwait Theater of Operations (KTO).

Beginning in late 1995, both the U.S. Intelligence Community and DoD's Persian Gulf Illness Investigation Team (PGIIT) began a thorough review of Iraqi chemical capabilities during Operations Desert Storm/Desert Shield and the demolition of munitions at the Khamisiyah ASP. These investigations eventually led DoD to announce that "it now appears that one of these destroyed bunkers contained chemical weapons."<sup>3</sup> The following details what is currently known of the events at Khamisiyah ASP involving U.S. troops:

### Desert Storm Activities

At the opening of the Gulf War (January 1991), the U.S. Central Command (USCENTCOM) did not classify Khamisiyah as a chemical weapons storage site.<sup>4</sup> However, by late February 1991, the XVIII Corps (ABN) G-3 indicated that Khamisiyah was suspected of being a chemical weapons storage site.<sup>5</sup>

During the Air War of Operation Desert Storm (16 January - 1 March 1991), Coalition Force aircraft attacked Khamisiyah,<sup>6</sup> destroying scores of warehouses and several ammunition

<sup>1</sup> Objective GOLD was a military designation for the area around what was then referred to as the Tall al Lahm ASP. GOLD was an Objective for the 24th Infantry Division (Mechanized) during the Ground War phase. The XVIII Corps Desert Shield Chronology February 1991, 26 February 1991 entry; and Brigadier General Robert H. Scales, Certain Victory, (Washington: Office of the Chief of Staff, U.S. Army, 1993), Figure 5-1.

<sup>2</sup> This highway was referred to as "Highway 8" or "MSR [military supply route] 8." It became the major redeployment route to reach MSR "Texas" and "Virginia," which then led back into Saudi Arabia and the units' assembly areas. 20th EN Bde General Update and Unit Location Report, 3 March 1991.

<sup>3</sup> DoD News Briefing, 21 June 1996.

<sup>4</sup> Since Khamisiyah was not specifically listed as a suspected chemical weapons storage site, it was considered to be a conventional weapons storage site. CIA Timeline on Activities Involving Khamisiyah Depot, for June 1996 PAC briefing.

<sup>5</sup> XVIII Corps CTOC 26 February 1991 log entry, and supporting handwritten action message form.

<sup>6</sup> Khamisiyah was targeted 10 times, however, only 8 missions were completed; 5 were B-52G raids and 3 were attacks by fighter/bomber aircraft. Gulf War Air Planning Staff (GWAPS) database query log.

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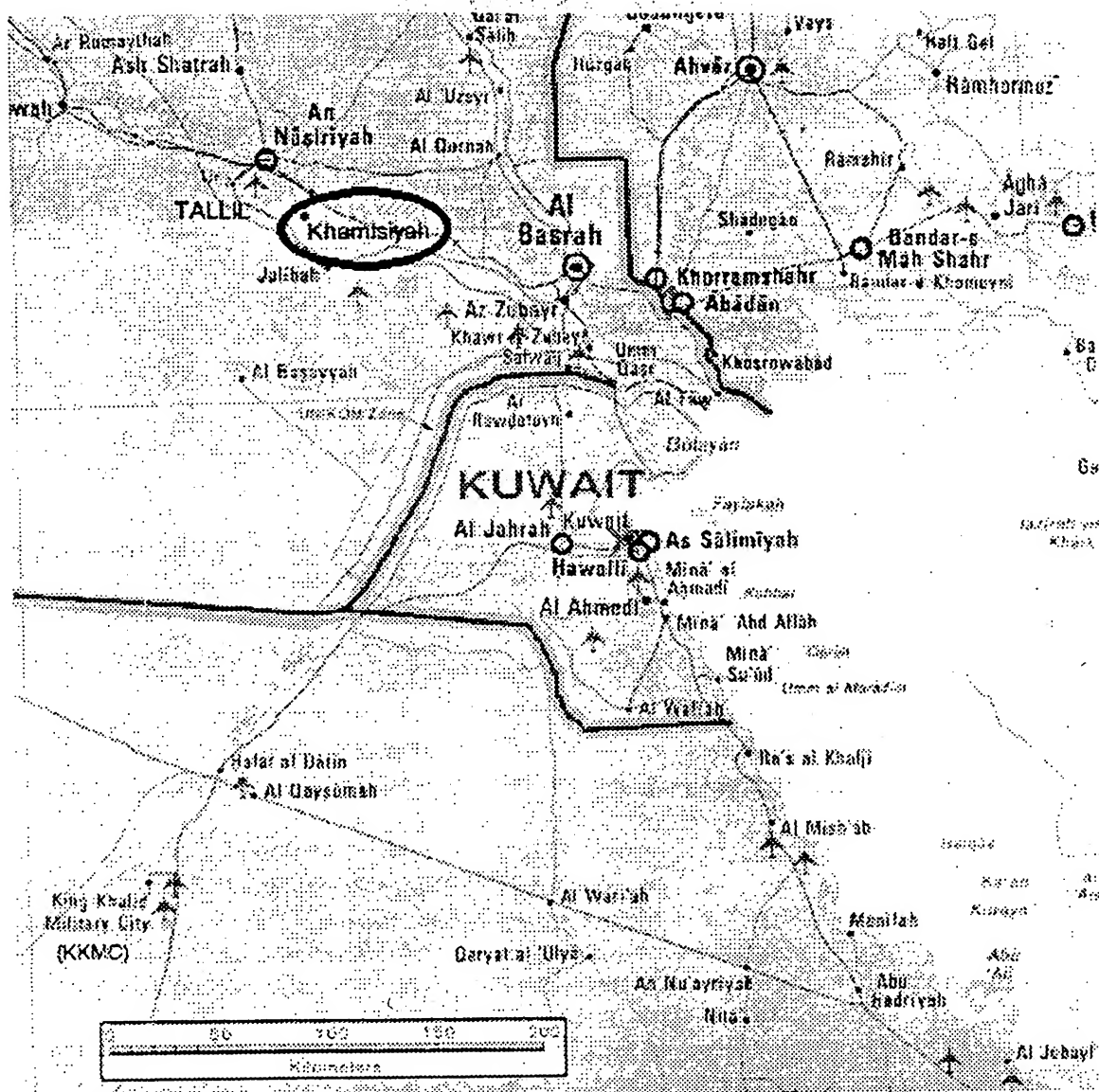


Figure 1 - Khamisiyah in the KTO.

bunkers.<sup>7</sup> At the commencement of the Ground War (24 February 1991), it was widely believed that U.S. Forces operating in the KTO after G-Day were likely to capture chemical warfare (CW) and, possibly, biological warfare (BW) munitions of various types.<sup>8</sup> Accordingly, all command levels issued Commander's Guidance for Disposition of Captured Chemical and Biological Munitions and other directives for dealing with captured Iraqi CW

<sup>7</sup> When the 82<sup>nd</sup> Airborne Division arrived at Khamisiyah on 1 March 1991, they saw evidence of this bombing destruction. Leavenworth 5+1 Press Conference video, 15 November 1996.

<sup>8</sup> Testimony by General (ret.) Schwarzkopf, 29 January 1997, before the Senate Veterans Affairs Committee.

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or BW munitions (see USCINCCENT on 24 February 1991<sup>9</sup>, COMUSARCENT on 21 February 1991<sup>10</sup>, and XVIII Corps (ABN) on 27 February 1991<sup>11</sup>). For example, the Commander, 24th Infantry Division (Mechanized) (ID(MECH)), also issued a memorandum on 16 February 1991<sup>12</sup> detailing the guidance for handling these items. The handling/disposition of CW or BW munitions guidance documents emphasized safety and security for both Coalition Forces and the local population:

Destruction of munitions or bulk agent will be accomplished in accordance with established EOD field disposal policies and procedures to ensure the complete and safe destruction of the captured items. Prior to destruction, all necessary measures to preclude collateral damage or down-wind hazard to friendly forces and civilians will be accomplished.<sup>13</sup>

### **Destruction of Munitions at Khamisiyah ASP**

The XVIII Corps (ABN) had the mission to conduct movement to contact operations, including attacking and securing Objective GOLD (later identified as Khamisiyah). On 26 February 1991, the first US troops to reach Khamisiyah were from the 24th ID(MECH).

On the northern end of BP 102, LTC John Craddock maneuvered his 4-64th Armor Battalion toward a canal north of Highway 8....Continuing north, the battalion overran a huge, untouched ammunition storage area and pushed the beaten Iraqis protecting the facility into the weeds near the canal.<sup>14</sup>

On 26 February 1991, the 24th ID(MECH) received information from the XVIII Corps (ABN) that there were "possible chemicals on Objective GOLD."<sup>15</sup> On 27 February 1991, the 24th ID(MECH) secured Objective GOLD<sup>16</sup> and continued eastward beyond Khamisiyah to cut-off retreating Republican Guard divisions near Basrah. On 28 February 1991, the 82nd Div (ABN) was located west of the 24th ID (MECH) with the "3rd Brigade conduct[ing] movement to Objective GOLD;"<sup>17</sup> the Objective was secured on 1 March 1991.<sup>18</sup> Although there is no evidence to date that the 82nd Div (ABN) received the warning

<sup>9</sup> Commander's Guidance for Disposition of Captured Chemical and Biological Munitions, USCINCCENT, 241200Z FEB 91

<sup>10</sup> Iraqi Chemical Munition Disposition, COMUSARCENT, 211400Z FEB 91

<sup>11</sup> Captured Chemical and Biological Munitions, XVIII Corps (ABN), 270845Z FEB 91

<sup>12</sup> Memo, Commander, 24th ID(M), SUBJ: Destruction of Enemy Equipment and Supplies, 16 February 1991.

<sup>13</sup> Commander's Guidance for Disposition of Captured Chemical and Biological Munitions, USCINCCENT, 241200Z FEB 91, para. 3D.

<sup>14</sup> Brigadier General Robert H. Scales, Certain Victory, (Washington: Office of the Chief of Staff, U.S. Army, 1993), p. 257-259

<sup>15</sup> An XVIII Corps February 26, 1991 log entry, and the supporting handwritten action message form.

<sup>16</sup> XVIII Corps (ABN) SITREP, 27 February 1991, p. 5.

<sup>17</sup> XVIII Corps (ABN) SITREP, 28 February 1991, p. 5.

<sup>18</sup> 2/505 one page history summary.

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from the XVIII Corps (ABN) of possible chemicals on Objective GOLD, in reporting activities that occurred in securing Khamisiyah, the 82nd Div (ABN) Chemical Officer noted that standard procedures were followed:

When the 82nd Div (ABN) initially occupied the sector, FOX vehicles and unit reconnaissance teams checked for evidence of contamination or chemical weapons. No contamination was found. Riot control agent CS was found in the Tall al Lahm ASP.....White phosphorus [artillery] rounds were also found. Artillery rounds with fill plugs and central bursters were found. They were marked with a yellow band. They were empty. Other rounds in the area were marked similarly. FOX reconnaissance determined they [the rounds] contained TNT.<sup>19</sup>

On 1 March 1991, the 2nd Platoon, Charlie Company, 307th Engineer Battalion, in direct support of TF 2-505, part of the 82nd Div (ABN), reconnoitered Khamisiyah ASP and concluded that demolition operations would require additional engineer support. Subsequently, the 37th Engineer Battalion was told to destroy the approximately 100 bunkers at Khamisiyah ASP.<sup>20</sup>

On 2 March 1991, the XVIII Corps (ABN) noted:

XVIII ABN Corps continues defensive/ security operations in zone with emphasis on force protection, clearing of residual enemy personnel in sector and destruction/evacuation of captured enemy equipment. Now that the tempo has dropped, units are able to begin clearing bunker complexes that were initially bypassed to maintain momentum. Divisions are discovering large numbers of bunkers/underground complexes containing weapons, ammunition and other materials. Destruction of these bunkers has already begun; however, the enormity of the task before us and amount of resources required is still unknown.

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Commander's evaluation... Our emphasis is on protection of the force and operations.<sup>21</sup>

Early on 2 March 1991, a platoon from Charlie Company, 37th Engineer Battalion arrived at the Khamisiyah ASP as an advance party for the battalion.<sup>22</sup> Upon its arrival, the unit found

<sup>19</sup> 82nd Chemical Officer's handwritten message to 2nd ACR Chemical Officer, 23 March 1991, describing activities that had occurred in AO.

<sup>20</sup> ENSITREP, March 3, 1991. The 37th Engineer Battalion was attached to the 82nd Div (ABN) for this purpose. The 37th Engineer Battalion was tasked through its chain of command, the 937th Engineer Group and the 20th Engineer Brigade.

<sup>21</sup> XVIII Corps (ABN) SITREP, 2 March 1991, pp. 3-4, 8.

<sup>22</sup> Personal recollection of unit commander. Leavenworth 5+1 Press Conference video.

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a large number of the local civilians and many animals inside the ASP; many were inside the bunkers as well.<sup>23</sup>

On 3 March 1991, the remainder of the 37th Engineer Battalion (-)<sup>24</sup> and two teams (three soldiers each) from the 60th Explosive Ordnance Disposal Detachment (EOD) arrived at Khamisiyah.<sup>25</sup> The battalion had M8A1 chemical alarms mounted on various unit vehicles, and these were reported to be operational.<sup>26</sup> The battalion's chemical noncommissioned officer (NCO) stated he was in "MOPP 4"<sup>27</sup> and checked<sup>28</sup> some of the bunkers for chemical agents. The results of these checks were reported to be negative. As part of the operation, the U.S. troops searched the site for any "special" weapons, that is chemical weapons and laser- or optically-guided munitions. They found one rocket with possible intelligence value; all remaining were deemed conventional.<sup>29</sup> Two bunkers (98 and 99) were exploded to test demolition techniques.<sup>30</sup>

On 4 March 1991, the three line companies of the 37th Engineer Battalion, assisted by the two teams of the 60th EOD, were each assigned 12 to 14 bunkers to inventory and demolish.<sup>31</sup> According to the Charlie Company Commander, "the explosive ordnance guys came through and said, here's what you're looking at. These are safe to destroy."<sup>32</sup> Therefore, the engineers planned to use the explosives necessary to destroy conventional munitions. A total of 38<sup>33</sup> bunkers were rigged with explosives, including the bunker subsequently reported by the Iraqis as containing chemical munitions (Bunker 73). Reports and interviews<sup>34</sup> indicate that approximately 300 engineer and EOD personnel participated in the demolition at the ASP, and about 770 additional personnel from the 505th Infantry secured the area.

<sup>23</sup> Documented in interviews with soldiers present. Unit ISG interview, Lead Sheet 843, July 1996.

<sup>24</sup> A (-) symbol indicates that the unit has detached part of its unit strength (personnel or units) to another area or mission. (Army manual FM 21-30, p. B-3; FM 101-5-1, Ch. 2, Sec. IV, p. 2-73). In this instance, the 37th EN Bn had begun redeploying its headquarters and much of its heavy equipment back to assembly areas in Saudi Arabia. Likewise, the 60th EOD had dispatched teams to different areas to support search and destroy operations by other 82nd DIV (ABN) units.

<sup>25</sup> Detailed in 37th EN Bn Operations Log, 24 February to 10 Mar 1991.

<sup>26</sup> Unit ISG stated, "Each platoon had M-8 on at all times." Lead Sheet 843, July 1996.

<sup>27</sup> MOPP (mission oriented protective posture) ensemble is worn at certain levels, from 0 (nothing) to 4 (mask with hood, Battle Dress Overgarment (BDO), butyl rubber gloves and overshoes). (Army manual FM 17-15, App. D, Section II).

<sup>28</sup> These "checks" were described by the NBC NCO to consist of performing M256 kit tests.

<sup>29</sup> Interview with EOD NCOIC, Lead Sheet 806, June 1996.

<sup>30</sup> 37th EN Bn Operations Log, 24 February to 10 Mar 1991.

<sup>31</sup> Both the 37th EN Bn and the 307th EN Bn lacked sufficient explosives to completely destroy all the warehouses and bunkers in Khamisiyah. In order to complete the task, the engineers made use of the explosives they found on-site; most of this explosive material consisted of the Soviet version of military C-4 explosive. 37th EN Bn message, SUBJ: Time Fuze, 4 March 1991.

<sup>32</sup> MAJ Huber's statement on CBS Evening News, February 12, 1997.

<sup>33</sup> Number of bunkers rigged is based on Unit commander's personal log entries and Leavenworth 5+1 Press Conference video.

<sup>34</sup> Interviews with 37th EN Bn CSM and Commander, Lead Sheet 819, June 1996 and Interview Notes, June 1996.

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At approximately 1400 hours on 4 March 1991, 37 of the 38 bunkers exploded (explosives in Bunker 92 failed to go off due to a bad time fuse).<sup>35</sup> The weather was clear, with winds coming from the SW.<sup>36</sup> The engineer battalion set up an observation point approximately 3 to 4 kilometers northwest, and crosswind of the Khamisiyah ASP (see unit location on Figure 2).

At approximately 1445 hours on 4 March 1991, an M8A1 chemical alarm in Bravo Company, 37th Engineer Battalion sounded at the observation point. Since troops were at MOPP 0,<sup>37</sup> upon hearing the alarm, some went to MOPP 4 status, and others only donned their masks.<sup>38</sup> Each company and EOD team<sup>39</sup> performed several M256 kit tests.<sup>40</sup> Two NBC NCOs interviewed say they got "weak" or "slightly" positive results on M256 tests, although the test kit is designed to show either positive or negative results. The Bravo Company Commander observed the test performed by his NBC NCO and states he saw a negative result, not a "weak positive." The second NBC NCO states he did a second test that was negative.<sup>41</sup> <sup>42</sup> An "all clear" was then signaled. Interviews of medical personnel at battalion/brigade/division/corps-level did not reveal any evidence of symptoms or health problems related to chemical warfare agent exposure during the entire period in question.<sup>43</sup> Debris from the exploding bunkers (described as fragments, and in some instances intact weapons) landed in or near the observation point, so troops were moved further away from Khamisiyah.<sup>44</sup>

On 5 March 1991, there were heavy rains in the morning, and many vehicles became stuck. The 60th EOD teams examined the bunkers from the previous day's demolition and determined one bunker (92) did not explode. The explosives were re-fused and set off without incident.<sup>45</sup> EOD reviewed the results of the previous day's demolitions and decided to use a different technique to destroy the remaining bunkers.<sup>46</sup> Alpha Company of the 307th

<sup>35</sup> 37th EN Bn Operations Log, 24 February to 10 Mar 1991.

<sup>36</sup> Photograph of 4 March 1991 explosion at Khamisiyah showing flag blowing.

<sup>37</sup> MOPP level of protection was reduced (from level 2 to 0) based on the cessation of hostilities. The XVIII Corps (ABN) Desert Shield Chronology, February 1991, 271940Z February 1991 entry. (Higher MOPP levels were used when a unit was initially entering the bunker areas. 37th EN Bn NBC NCO interview and Lead Sheet 1094, October 1996.)

<sup>38</sup> EOD NCO interview, Lead Sheet 1077, October 1996.

<sup>39</sup> EOD NCO interview, Lead Sheet 1077, October 1996.

<sup>40</sup> Leavenworth 5+1 Press Conference video.

<sup>41</sup> Interview of NCO and commander, Lead Sheets 825 and 832, June 1996

<sup>42</sup> This information regarding negative detections is what is known to date and may be modified as the result of survey information. In January 1997, surveys were sent to people believed to have been within 50km of Khamisiyah, seeking additional information.

<sup>43</sup> Statement by Commander, 307th Medical Bn.

<sup>44</sup> Reports indicate fragments fell in the area for 5 to 30 minutes, and secondary explosions of munitions continued for 24 hours. Personal interviews, Unit NCO interview, Lead Sheet 1223, January 1997.

<sup>45</sup> Leavenworth 5+1 Press Conference video.

<sup>46</sup> This review of demolition techniques was, in part, prompted by a reported lack of explosives available to the engineers, concern about the amount of secondary explosions, and the extent of unexploded ordnance

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Engineer Battalion<sup>47</sup> was given the mission to destroy warehouses in the NW portion of Khamisiyah ASP. The XVIII Corps (ABN) SITREP for this day also noted that the 82nd Div (ABN) destroyed ASPs at Jalibah and Tallil. There is no mention of Khamisiyah or Objective GOLD.<sup>48</sup>

On 6 March 1991, each engineer company of the 37th Engineer Battalion and Alpha Company from the 307th Engineer Battalion exploded a bunker to test the latest techniques for demolition developed by the 60th EOD. The EOD experts wanted bunkers to implode to reduce<sup>49</sup> the number of secondary explosions and to conserve the amount of explosives used. During 7-9 March 1991, no demolitions were performed because of poor weather. The time was used for demolition training, rehearsals, and inventorying<sup>50</sup> the remaining bunkers and warehouses.

On 9 March 1991, the Operations Officer of the 37th Engineer Battalion found crates of 122mm rockets outside the SE corner of Khamisiyah ASP.<sup>51</sup> A noncommissioned officer from the Headquarters & Headquarters Company (HHC) of the battalion was told to destroy these munitions in what is now called the "pit" area of Khamisiyah.<sup>52</sup>

On 10 March 1991, at approximately 1540 hours, crates of rockets in the "pit" were detonated. At the same time, the 60 remaining bunkers were detonated by 37th Engineer Battalion, and the warehouses were blown up by Alpha Company of the 307th.<sup>53</sup> There is some confusion as to whether the HHC NCO with a two-man detail was the only group setting explosives in the "pit." Photo analysis of the "pit" reveals 13 separate stacks of material. The HHC NCO and one of his detail both state they rigged 3 stacks of rockets for demolition, no other stacks were observed, and no one else was working in the "pit." However, an EOD NCO says he led a 15 - 20 man engineer/soldier detail that destroyed

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(UXO) caused by the March 4, 1991 demolition. Interview with unit commander, Lead Sheet 1266, January 1997, and 37th EN Bn mission update, March 1991.

<sup>47</sup> This unit, along with another team from the 60th EOD, arrived at Khamisiyah on 4 March 1991. Leavenworth 5+1 Press Conference video.

<sup>48</sup> XVIII Corps (ABN) SITREP, 5 March 1991, p.4.

<sup>49</sup> The test explosions did not produce the desired results. However, it was decided to change the charger method from individual bunkers to a singular ring main that included all the warehouses and bunkers. The net result would be one large explosion versus individual explosions timed to go off at approximately the same time. Leavenworth 5+1 Press Conference video.

<sup>50</sup> The IAD does not have any detailed inventories of what was actually in the ASP bunkers and warehouses. Personnel on site have stated there was not sufficient time to do an exact count of munitions, and that most of the containers had Arabic writing, which was indecipherable to the troops. IAD does have an aggregate inventory report from the 307th EN Bn and 82nd DIV (ABN) reports, and videotape showing inside some bunkers. 307th EN Bn Operations Summary, and 60th EOD Incident Journal (Desert Storm)

<sup>51</sup> Interviews with BN S-3, Lead Sheet 1053, October 1996 and 307th Liaison Officer, Lead Sheet 1221, January 1997.

<sup>52</sup> HHC S-2 NCO interview, Lead Sheet 857, July 1996.

<sup>53</sup> Leavenworth 5+1 Press Conference video.

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approximately 850 rockets (6 to 8 stacks) in the "pit" on the same day as the "big explosion" on March 10.<sup>54</sup>

An accounting of demolition at the "pit" is also noted in the 60th EOD log<sup>55</sup> for 12 March 1991. It was recorded that 840 "5-inch" (this measure approximates 122mm) rockets were destroyed at coordinates for Khamisiyah ASP. This report, however, conflicts with information provided by an NCO from the 60th EOD.<sup>56, 57</sup>

The 37th Engineer Battalion observation point for the demolition on 10 March 1991 was south of Khamisiyah on MSR 8, approximately 20-30 minutes travel time by vehicle away from the ASP. Once they heard explosions, the 37th continued south towards Saudi Arabia<sup>58</sup> for approximately four more hours. The weather was overcast skies with poor visibility; wind direction and speed on this date are the subject of ongoing investigation by the Institute for Defense Analysis (IDA) and CIA.

On 12 March 1991, the 307th Engineer Battalion<sup>59</sup> identified additional ammunition stores southwest of Khamisiyah ASP, described as "another enemy bunker complex of more than 400 revetted bunkers with large caches inside."<sup>60</sup> During the period 15-19 March 1991, the 307th Engineer Battalion rigged explosives on the munitions found in the berm area southwest of Khamisiyah ASP. On March 20, the berm area was detonated at approximately 1530 hours.<sup>61</sup>

On 23 March 1991, the 2nd Armored Cavalry Regiment, part of the U.S. VII Corps, assumed responsibility for the area of operations, which included Khamisiyah. The 84th Engineer Company and the 146th EOD were among their supporting units. On 24 March 1991, the 82nd Div (ABN)<sup>62</sup>, the 307th Engineer Battalion, and the 60th EOD departed for Saudi Arabia and subsequent redeployment.<sup>63</sup>

On 27 March 1991, the 2nd Armored Cavalry Regiment was told to determine if Tall al Lahm Ammo Storage Depot South (100 revetments) and Tall al Lahm Ammo Storage

<sup>54</sup> HHC S-2 NCO interview, Lead Sheet 857, July 1996 and EOD NCO interview, Lead Sheets 910 and 1077, September and October 1996, respectively.

<sup>55</sup> 60th EOD Incident Journal (Desert Storm), 1 April 1991.

<sup>56</sup> EOD NCO interview, Lead Sheet 910, September 1996.

<sup>57</sup> This conflict in reports gives rise to the question of whether there was more than one "big explosion." IAD continues to seek identification of the individual soldiers involved in the demolition so as to resolve that question.

<sup>58</sup> The 37th EN Bn (-) continued to the assembly area (AA ELM) to link-up with the remainder of their soldiers in preparation for redeployment to Ft. Bragg. Operations Log, 37th EN Bn for 24 February to 10 March 1991.

<sup>59</sup> The remainder of the 307th EN Bn arrived in Khamisiyah 11-12 March 1991 from Tallil. Leavenworth 5+1 Press Conference video.

<sup>60</sup> XVIII Corps CTOC Journal Sheet, 12 March 1991

<sup>61</sup> Leavenworth 5+1 Press Conference video.

<sup>62</sup> Brigadier General Robert H. Scales, Certain Victory, (Washington: Office of the Chief of Staff, U.S. Army, 1993), p.326

<sup>63</sup> 307th EN Bn Desert Storm Narrative, 17 May 1991.

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Facility [Khamisiyah] contained possible chemical/biological munitions.<sup>64</sup> On 28 March 1991, the unit reported to VII Corps that chemical/biological reconnaissance of both Tall al Lahm sites yielded negative results.<sup>65</sup>

On 2 April 1991, the 82nd Engineer Battalion, located south of the area of operations, reported hearing a large explosion in the vicinity of Tallil, another site of demolition, approximately 40 km from Khamisiyah.<sup>66</sup>

On 6 April 1991, members of the 84th Engineer Company and 146th EOD re-examined bunkers at Khamisiyah ASP, and determined that six bunkers required additional detonations to destroy remaining munitions.<sup>67</sup>

The last American units departed Khamisiyah in late April 1991.

Further details on this chronology are being gathered in the continuing investigation by the Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illnesses.

### UNSCOM Investigations at Khamisiyah

In April 1991, the UN Security Council adopted Resolution 687, setting specific terms for a formal cease-fire to end the conflict between Iraq, Kuwait and the countries cooperating with Kuwait.<sup>68</sup> In May 1991, in response to UN Security Council Resolution 687, the Iraqis declared to UNSCOM that "Khamisiyah (Nasiriyah)" was a chemical weapons storage site, although it was not included in their first declaration to the UN in April 1991. This was confusing information because it referred to two locations, a known site (Nasiriyah), and an as yet unknown site (Khamisiyah).

In October 1991, UNSCOM sent a team to inspect six of the sites which were not near Baghdad. The site map provided to the UNSCOM Team was labeled "An Nasiriyah Depot S.W. (Khamisiyah)," and it depicted the layout of what U.S. Intelligence knew as An Nasiriyah ASP. However, the UNSCOM Team was not taken to An Nasiriyah, but to a different site, which is now known to be Khamisiyah. They were shown artillery shells and rockets in two separate areas apart from the main ASP (see Figure 2). An open area, 3 kilometers west of the bunkers, contained 6,323 155mm artillery shells filled with mustard agent. These shells were undamaged and were stored in an orderly fashion (in several stacks/clusters) under tarpaulins, using the natural terrain features to hide them. The second

<sup>64</sup> VII Corps FRAGO # 189-91, 27 March 1991

<sup>65</sup> VII Corps Tactical Chemical Spot Report, 28 March 1991

<sup>66</sup> Report in unit history file states other U.S. unit was conducting demolition mission at Tallil Air Base.

<sup>67</sup> 84th EN Co. Commander's comments in the Leavenworth 5+1 Press Conference video.

<sup>68</sup> A provision of UN Security Council Resolution 687 established the UN Special Commission (UNSCOM) whose primary Objectiveective was to identify Iraqi chemical and biological weapons and ballistic missiles which survived the war, have them moved to an Iraqi destruction facility, or to destroy the weapons themselves. UN Security Council Resolution 687

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area, located in a "pit" south of the main bunker complex, contained 297 122mm rockets in three to four "heaps," some of which were damaged but most were intact. Some rockets were neatly laid out, while others appeared to have been bulldozed into piles or heaps. Many rockets were leaking, and plastic inserts and other features characteristic of chemical munitions were observed, so UNSCOM personnel drilled into one of the intact rockets to take a sample. The sample was later analyzed and found to be a chemical warfare nerve agent (sarin/cyclosarin (GB/GF)).

The Iraqis told UNSCOM in 1991 that chemical rockets found in the "pit" had been salvaged from Bunker 73, which had been destroyed as part of the demolition operations by Coalition Forces. UNSCOM acknowledged that Bunker 73 appeared damaged, but did not thoroughly inspect the bunker. Chemical agent monitoring at the bunker site was negative. No other observations were documented concerning remains of munitions, such as whether there were observable plastic inserts or other paraphernalia characteristic of chemical munitions.

In November 1991, the U.S. Intelligence Community became aware of the results of the UNSCOM Khamisiyah Ammunition Storage Facility site visit.<sup>69</sup> The U.S. Intelligence Community did not believe Iraqi accounts to the UN that chemical weapons had been blown up at Khamisiyah by the coalition forces at the end of the war.<sup>70</sup> They believed the Iraqis were engaged in possible deception, consistent with the observations of UNSCOM in their inspections and analysis of Iraqi declarations.<sup>71</sup>

Despite their doubts, intelligence analysts initiated a search for any U.S. units involved in blowing up munitions at Khamisiyah. A response to their request dated 12 November 1991 indicates that they had "received information from ARCENT [the Army Central Command] to the fact that 24th Mechanized Infantry Division was located in the vicinity of Tall al Lahm, but [were] unable to confirm if U.S. troops did in fact destroy buildings at this particular site."<sup>72</sup> ARCENT mistakenly identified the 24th Infantry Division as being in the area at the time, although they had not carried out the demolition at Khamisiyah. The ARCENT lead was followed, and a 20 November 1991 message notes that "Info on Tall al Lahm Ammo Depot was passed to ... G-2 Office, Ft. Stewart, GA," Headquarters of the 24th Mechanized Infantry Division. Further, this message states "info on presence of troops there and their activities during Desert Storm were requested...."<sup>73</sup> The IAD has followed that lead; after more than five years, the person contacted at Fort Stewart has no specific recollection of being contacted or of any specific subsequent actions taken. Additional follow-up has provided no further leads at this point.<sup>74</sup>

<sup>69</sup> Redacted Message, 12 November 1991.

<sup>70</sup> Mr. Denny Ross, CBS News, 12 February 1997.

<sup>71</sup> S/23268, Letter from Executive Chairman, Office of the Special Commission, 4 December 1991, p. 2.

<sup>72</sup> Redacted CIA declassified message, 12 November 1991.

<sup>73</sup> Redacted CIA declassified message, 20 November 1991

<sup>74</sup> Memorandum, XX February 1997, Discussions with the 24 ID G-2 staff.

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During a March 1992 visit, the UNSCOM Team consolidated and destroyed at least 500 122mm rockets. According to the UNSCOM press release<sup>75</sup> on 30 March 1992, the munitions destroyed included full, partially full, and empty rockets. This number includes the 297 rockets mentioned previously, which were found in the "pit". In addition to the rockets destroyed in the March 1992 site visit, more than 200<sup>76</sup> rockets were unearthed by the Iraqis in the "pit" and shipped to Al Muthanna for destruction. More than 700 rockets or major rocket parts in all were found in the "pit" area. The actual number of rockets in the "pit" and Bunker 73 is unknown, and continues to be topic of questioning during interviews with 1-800 callers and other interviewees.

### The Public Inquiry

In February 1994, Congressman Browder (D-AL) requested from the UN any reports pertaining to chemical weapons found in Iraq after the Gulf War. The UN responded by letter in April 1994, providing in tabular format a listing of the sites at which Iraqi chemical warfare agents/weapons were found. Included in this listing was the "Khamisiyah Storage Site."<sup>77</sup>

In May 1994, witnesses from DoD testified before the Senate Banking, Housing, and Urban Affairs Committee (the Riegle Committee) on matters relating to export administration. In the course of that testimony, DoD witnesses acknowledged that the UN had found chemical munitions at a site, 15 nautical miles from An Nasiriyah, but stated that U.S. forces were not at that site, which they said was north of the Euphrates River.<sup>78</sup> Review of the testimony and responses to questions for the record submitted by DoD in September and October 1994 reveals that there was true confusion as to the location of Khamisiyah and its proximity to US troops. Furthermore, DoD believed that any destruction of chemical munitions at this "other site" (Khamisiyah) probably had occurred after the war as part of an Iraqi deception campaign.<sup>79</sup>

This belief formed the basis for information provided to the Defense Science Board Task Force Persian Gulf War Health Effects in June 1994. The Task Force report stated that:

There were also reports of damage by the United Nations Special Commission inspection team that visited a different location in the general vicinity of An Nasiriyah several months after the cessation of hostilities.

<sup>75</sup> Unclassified UNSCOM Press Release, 1 April 1992

<sup>76</sup> Reuters News Agency summary, Subject: Iraq-Chemical, 25 June 1992.

<sup>77</sup> Letter responding to Congressman Browder's request, UNSCOM, 5 April 1994

<sup>78</sup> Transcript of Hearing, Senate Banking Committee, 25 May 1994, pp. 135-137. Mr. Edwin Dorn, Under Secretary of Defense for Personnel, Dr. Theodore M. Procv, Deputy Assistant to the Secretary of Defense for Chemical and Biological Weapons, and Dr. John Kriese, Chief Officer for Ground Forces, Defense Intelligence Agency.

<sup>79</sup> Responses to questions for the record submitted to Congressman Riegle on 22 September and 5 October 1994

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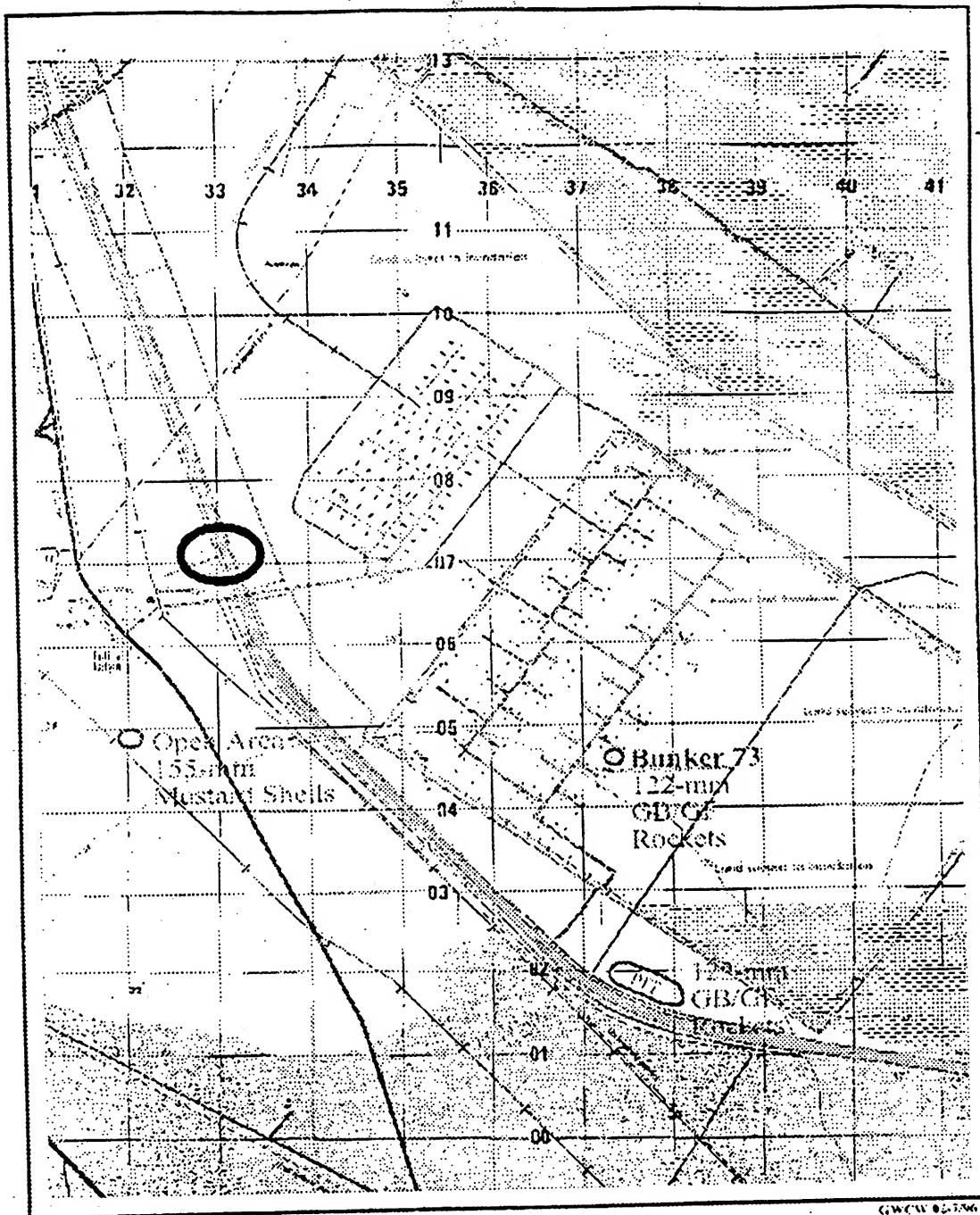


Figure 2. Close-up View of Khamisiyah (Bunkers, Location of 155mm shells, and "pit").

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There are indications that the site visited by the UNSCOM team was not a site targeted during the air war but may have been specially constructed for the UN inspectors.<sup>80</sup>

In November 1994, Congress directed the expansion of a DoD Gulf War registry, to include all servicemembers.<sup>81</sup> The agency tasked with responsibility for compiling the unit locator database was the Environmental Support Group (ESG) (now referred to as the U.S. Armed Services Center for Research of Unit Records). The ESG unit locator database incorporates all available coordinates (both latitude/longitude and universal trans-mercator indices) derived from unit logs, situation reports, etc. It reports the location of many, but not all, of the U.S. units in Iraq and Saudi Arabia during the conduct of the Gulf War by unit identification codes (UICs) and time.

In March 1995, the President directed<sup>82</sup> a more intensive effort to discover the causes of illnesses among Gulf War veterans. As concern over the Gulf War illnesses mounted the Acting Director Central Intelligence directed the CIA to conduct a comprehensive review of relevant intelligence information. In this review the CIA focused on identifying and quantifying Iraqi chemical, biological, or radiological releases during and after the war that could have reached U.S. troops.<sup>83</sup> As part of the President's initiative, the DoD and the CIA initiated new efforts to collect and review operational, intelligence and medical records from the war. In April, declassification of health documents started, and in June 1995, the Persian Gulf Illnesses Investigation Team (PGIIT) was established to provide a DoD organization to manage the different investigations which were now on-going.

Just prior to September of 1995, CIA analysts resurfaced the UNSCOM October 1991 Khamisiyah site visit report during a re-examination of thousands of intelligence reports and other intelligence holdings. On 6 September 1995, the CIA identified Khamisiyah as a key unresolved chemical weapons release issue, which raised special concern because its southerly location put it closest to U.S. troops. On 13 September 1995, CIA informed DoD's PGIIT of Khamisiyah's potential relevance to the exposure issue and asked whether U.S. military forces had been at the site.<sup>84</sup> DoD searched the newly constructed ESG unit locator database and indicated that some units were in the area. In October 1995, PGIIT learned from the ESG that the 37th Engineer Battalion reported a location coordinate near Khamisiyah, but there was no indication of their mission. At that time, no follow-on investigation into the 37th Engineer Battalion activities was conducted.

<sup>80</sup> The Defense Science Board Task Force Report on Persian Gulf War Health Effects, p. 32, June 1994.

<sup>81</sup> Public Law 102-109, DoD to Establish PG Registry, and Public Law 102-585, Sec. 704, Expansion of Coverage of Persian Gulf Registry. The original registry was developed to identify veterans exposed to the Kuwait oil well fires.

<sup>82</sup> DoD News release, ref. # 116-95, 9 Mar 95.

<sup>83</sup> CIA Chronology of Khamisiyah Events, transmitted to Special Assistant for Gulf War Illnesses Executive Director, CIA on 24 January 1997.

<sup>84</sup> CIA Chronology of Khamisiyah Events, transmitted to Special Assistant for Gulf War Illnesses Executive Director, CIA on 24 January 1997.

Reference footnotes 83 and 84: This chronology was superseded by the CIA Update published on April 9, 1997.

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The CIA continued to monitor the DoD's Khamisiyah investigation and to conduct their own research. On 26 January 1996, the CIA briefed the National Security Council (NSC) staff that U.S. troops probably blew up chemical weapons at Khamisiyah. The Presidential Advisory Committee (PAC),<sup>85</sup> formed in May 1995, was subsequently made aware of these initial findings. DoD and the CIA began an intense and comprehensive effort to research and analyze the Khamisiyah events. Concern about U.S. exposure increased as the topic became more fully understood. By early March 1996, CIA and PGIIT pieced together previously unanalyzed information indicating activity at the Khamisiyah ASP, and, for the first time, they received clear indications that the 37th Engineer Battalion blew up Bunker 73 at Khamisiyah.

On 10 March 1996, a CIA analyst heard a tape recording of a radio show during which a veteran (Mr. Brian Martin) of the 37th Engineer Battalion described demolition activities at a facility the analyst immediately recognized as Khamisiyah.<sup>86</sup> Although Mr. Martin had previously testified before the House Veterans Affairs Committee and had been contacted by DoD after the release of the Riegle report,<sup>87</sup> it was not until the CIA analyst heard the 10 March 1996 broadcast that the possible connection between An Nasiriyah demolitions and the bunkers at Khamisiyah was drawn. DoD and the PAC were notified of this connection on 11 March 1996.

A PGIIT investigator contacted Mr. Martin on 11 March 1996 about the demolition he had witnessed, and, with assistance from the PAC, Mr. Martin provided a video tape that showed the demolition activities he had witnessed. Another version of the tape<sup>88</sup> confirms the event on Mr. Martin's tape as the demolition at Khamisiyah on 4 March 1991. Review of these tapes has provided much useful information to the investigation by confirming events and weather data. Unfortunately, no such video, photographs or logs have been found that document the 10 March 1991 demolition.

On 1 May 1996, the CIA publicly announced at a PAC hearing that UNSCOM had found chemical weapons at Khamisiyah and, that "elements of the 37th Engineer Battalion.... performed demolition of munitions at this facility" during 1991.<sup>89</sup>

On 14 May 1996, UNSCOM again visited Khamisiyah. During this visit, the Iraqis told the inspectors that the 6,323 mustard rounds had been moved to Khamisiyah from Al Muthanna

<sup>85</sup> Established by Executive Order 12961.

<sup>86</sup> Executive Director of CIA testimony before the Senate Veterans Affairs Committee, 9 January 1997.

<sup>87</sup> Mr. Martin had previously testified before the House Committee of Veteran Affairs in November 1993, where he described his illness and reported that he had witnessed a scud attack, saw dead animals, took pyridostigmine, and was exposed to diesel fuel. Additionally, in May 1994, after release of the Riegle Committee report, DoD contacted him to ask if he thought he could have been exposed to chemical agents and, if so, how. He cited three possible sources of exposure: the scud attack at Wadi Al Batin, the dead animals, and smoke from a bunker destruction near An Nasiriyah.

<sup>88</sup> IAD obtained an original, uncut version of the videotape from Mr. Martin's Company Commander, Major Huber.

<sup>89</sup> Extract from Testimony of Executive Officer, Office of Weapons Technology and Proliferation, CIA, to the PAC, 1 May 1996.

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to An Nasiriyah in January 1991 after the beginning of the Gulf War. The Iraqis further stated that about 2,160 sarin/cyclosarin rockets were also brought from Al Muthanna in January 1991, and stored in Bunker 73 until a chemical leak was discovered, causing approximately 1100 of the rockets to be moved to the "pit" area in February 1991. According to the Iraqis, this was done before the Coalition Forces destroyed the ammunition storage area.

On 21 June 1996, DoD held a news briefing to detail these findings on Khamisiyah. The DoD said:

UNSCOM has informed us that, as part of its ongoing effort to verify Iraqi declarations, it inspected the Khamisiyah ammunition storage area last month [May 1996]. During that inspection, UNSCOM concluded that one bunker had contained rockets with chemical agents. U.S. soldiers from the 37th Engineer Battalion destroyed ammunition bunkers at this site in early March 1991, shortly after the war ended. Based on a new review of the available information, it now appears that one of these destroyed bunkers contained chemical weapons.<sup>90</sup>

After the 21 June 1996 announcement, the focus of investigation shifted to better understand two questions. First, what was the potential for exposure to chemical agents at Khamisiyah, and second, who might have been exposed. DoD merged the ESG unit locator database with DMDC personnel databases to identify the people actually deployed at varying distances from Khamisiyah ASP in early March 1991.<sup>91</sup> Efforts are on-going to identify additional units and individuals which were in the vicinity of Khamisiyah (see Tab B to this document). In addition, the PGIIT, CIA, and DMDC conducted interviews with U.S. troops known to be involved in the demolition to try to reconstruct such information as the exact dates of the demolition, amount and type of munitions destroyed, and weather and wind direction on the dates of demolition.

#### Potential for Exposure - Plume Analysis

The CIA was charged by the PAC<sup>92</sup> to develop prediction models of the potential chemical fallout from the March 1991 demolition operations using, among other models, the U.S. Army's Chemical and Biological Defense Command's NUSSE4 transport and diffusion model. The results were briefed to the PAC on 9 July 1996, and on 2 August 1996, the CIA published a report on the Bunker 73 explosion on 4 March 1991. They concluded that the likely movement of vapor was to the east and northeast away from U.S. troops.<sup>93</sup>

<sup>90</sup> DoD News Briefing, 21 June 96.

<sup>91</sup> The ESG database is known not to be definitive. See the PAC Report, January 1997, p. 30.

<sup>92</sup> Statement by CIA Executive Director at News Conference on Persian Gulf Veterans Illnesses, 1 November 1996.

<sup>93</sup> CIA Report on Intelligence Related to Gulf War Illnesses, 2 August 1996, and DefenseLINK News Release 681-96, 20 December 1996.

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The CIA encountered numerous modelling uncertainties, especially weather data, and could not come to any definitive conclusions. At this time DoD assumed responsibility for efforts to model the "pit" incident. On 22 November 1996, DoD asked IDA to convene an independent panel of experts in meteorology, physics, chemistry, and related disciplines to review all of the modelling efforts available in order to determine the potential fallout from the "pit" area demolition. IDA provided a progress report on 18 December 1996. At that time, IDA reported:

.... continued concern about the inability to describe the many variables of the agent-munition release mechanism. The panel agrees with the CIA that "huge uncertainties remain" in the number of rockets present for destruction and the number of those rockets destroyed. Among the other major variables for which there remains much uncertainty are total quantity of agent released, mechanism of release, and purity of agent.<sup>94</sup>

The expert panel is working with the DoD investigators and were briefed by CIA analysts in order to refine the model inputs and to see if the original dispersion and weather models or any other models may be useful in determining the possible extent of chemical exposure as a result of the Khamisiyah demolitions.

#### **Who Was At Khamisiyah**

On 7 August 1996, the Assistant Secretary of Defense for Health Affairs designed and conducted a telephone outreach to veterans who may have participated in the operation at Khamisiyah ASP. Based on a search of the ESG database and over 100 interviews, the PGIIT was able to determine units potentially involved in this operation. Individuals were selected for the telephone outreach based on their Gulf War assignment to one of these units.

DMDC identified 1179 individuals assigned to units thought to have participated in the operation. Of those identified, 542 individuals were contacted and completed the survey, 14 were uncooperative with telephone operators, and 12 individuals are deceased. The telephone outreach effort concluded in October 1996. All individuals who were not able to be contacted via the telephone were mailed a certified letter, informing them of the incident and requesting they share any information pertaining to the incident through the 1-800 hotline. 259 individuals received the certified letter but did not contact DMDC, and 352 individuals have yet to receive a letter because either it is in the process of being forwarded to them or they have no known address.

The personal descriptions of the incident offered by each individual completing the survey were analyzed to screen for potential leads for the continuing investigation. The PGIIT used the data as a basis for follow-up interviews. Of the total 542 contacted, 39 individuals mentioned chemical alarms sounding during this period. These 39 reports, and all subsequent

<sup>94</sup> DefenseLINK News Release, Reference Number 681-96, 20 December 1996.

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reports of chemical alarms sounding, are the subject of continuing examination and further analysis by the investigators of the IAD, the successor organization to PGIIT.

Given the uncertainty concerning the fallout from the "pit" demolition on 10 March 1991 and after careful review of the CIA's preliminary results, DoD decided to be conservative and notify all those who were thought to be within a 50 kilometer radius of Khamisiyah ASP between 1 March and 15 March 1991. Letters were sent to approximately 21,000 Gulf War veterans. The intent of these letters was to inform them of the incident; to inform them of the potential for low-level exposure to chemical warfare agent; to explain how to sign up for examination in the DoD or Department of Veterans Affairs registries; and to notify them of a forthcoming survey to query for specific unit/individual location information, chemical exposure data, and health and medical program participation questions. The most important part of the letter was:

We need to hear from you, not only about your experience in the vicinity of the site, but also about any health problems you think may be a result of your service during Operations Desert Storm/Desert Shield. Your timely response to the survey will provide us with critical information. If you have information that you believe would be of immediate value to us pertaining to the events at Khamisiyah, please call the PERSIAN GULF INCIDENT HOTLINE at 1-800-472-6719.

If you are experiencing health problems you believe to be a result of your service in Operation Desert Storm/Desert Shield and you are eligible for health benefits through the Department of Defense, please call the COMPREHENSIVE CLINICAL EVALUATION PROGRAM at 1-800-796-9699. If you are eligible for benefits provided by the Department of Veterans Affairs system, please call the PERSIAN GULF HELPLINE at 1-800-PGW-VETS.<sup>95</sup>

Mailing of the survey started 10 January 1997 and is still continuing.<sup>96</sup>

*This case is still being investigated. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DoD Persian Gulf Task Force Hot Line at 1-800-472-6719*

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<sup>95</sup> Copy of letter sent to vets.

<sup>96</sup> Copy of survey sent to vets.

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## TAB A - Acronym Listing/Glossary

This TAB provides a listing of acronyms found in this report. Additionally, the Glossary section provides definitions for selected technical terms which are not found in common usage.

### Acronyms

1SG.....	First Sergeant
AASLT.....	Air Assault
ABN.....	Airborne (type of unit)
ACR.....	Armored Cavalry Regiment (Army unit)
ADA.....	Air Defense Artillery
AMB.....	Ambulance
AO.....	Area of Operations
ARCENT.....	Army Central Command
ASP.....	Ammunition Storage Point
ATC.....	Air Traffic Control
AVN.....	Aviation
Bde.....	Brigade (Army unit)
BDO.....	Battle Dress Overgarment
Bn.....	Battalion (Army unit)
CAM.....	Chemical Agent Monitor
Cbt.....	Combat
CCEP.....	Comprehensive Clinical Evaluation Program
CENTCOM.....	Central Command
CIA.....	Central Intelligence Agency
Co.....	Company (Army unit)
COMUSARCENT.....	Commander, U.S. Army Central Command
COSCOM.....	Corps Support Command
CSG.....	Corps Support Group
CSM.....	Command Sergeant Major
CTOC.....	Corps Tactical Operations Center
DECON.....	Decontamination
Det.....	Detachment
DIA.....	Defense Intelligence Agency
DISCOM.....	Division Support Command
Div.....	Division
DIVARTY.....	Divisional Artillery
DMDC.....	Defense Manpower Data Center
DoD.....	Department of Defense (U.S.)
DVA.....	Department of Veterans Affairs
EN.....	Engineer (Unit designation)
ENSITREP.....	Engineer Situation Report
EOD.....	Explosive Ordnance Disposal

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ESG	Environmental Support Group
FA	Field Artillery (Unit designation)
FRAGO	Fragmentary Order
Fwd	Forward
GA	Georgia
GB	Nerve agent (sarin)
GF	Nerve agent (cyclosarin)
GWAPS	Gulf Air War Planning Staff
HHC	Headquarters and Headquarters Company
Hqs.	Headquarters
HTML	Hyper-Text Media Link
IAD	Investigation and Analysis Directorate
IN	Infantry (Unit designation)
KTO	Kuwaiti Theater of Operations
Maint.	Maintenance
MECH	Mechanized
mm	millimeter
MMC	Materiel Management Center
MOPP	Mission Oriented Protective Posture
MSR	Military Supply Route
MTF	Medical Treatment Facility
NBC	Nuclear, Biological, and Chemical
NCO	Non-Commissioned Officer
NCOIC	NCO In Charge
NSA	National Security Agency
NSC	National Security Council
NW	northwest
OBJECTIVE	Objectiveective
OSAGWI	Office of the Special Assistant for Gulf War Illnesses
OSD	Office of the Secretary of Defense (U.S.)
PGIIT	Persian Gulf Illnesses Investigation Team
POL	Petroleum, Oil and Lubricants
QM	Quartermaster
RMC	Regional Medical Center
S&S	Supply and Service
SE	southeast
SITREP	Situation Report
Spt	Support
Sqdn	Squadron (Army unit)
SW	southwest
TAC	Tactical
TF	Task Force
TOC	Tactical Operations Center
U.S.	United States
UIC	Unit Identification Code

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UN ..... United Nations  
 UNSCOM ..... United Nations Special Commission  
 USCINCCENT ..... Commander-in-Chief, U.S. Central Command  
 UXO ..... Unexploded Ordnance

### Glossary

**CCEP** Developed by a multi-disciplinary team of DoD and VA medical specialists, the CCEP provides a two-phase, comprehensive medical evaluation. Phase I is conducted at the local medical treatment facility (MTF) and consists of a history and medical examination comparable in scope and thoroughness to an in-patient hospital admissions evaluation. The medical review includes questions about family history, health, occupation, unique exposures in the Gulf War, and a structured review of symptoms.

Health care providers specifically inquire about the symptoms and Persian Gulf exposures listed on the CCEP Provider-Administered Patient Questionnaire. The medical examination focuses on patients' symptoms and health concerns and includes standard laboratory tests (complete blood count, urinalysis, serum chemistries) and other tests as clinically indicated.

Individuals who require additional evaluation after completing the MTF-level Phase I evaluation and appropriate consultations may be referred to one of 14 Regional Medical Centers (RMCs) for Phase II evaluations. RMCs are tertiary care medical centers that have representation from most major medical disciplines. Phase II evaluations consist of symptom-specific examinations; additional laboratory tests, and specialty consultations according to the prescribed protocol.

*Reference: CCEP Report dated 2 Apr 96, can be found on homepage:  
<http://www.ha.osd.mil/cs/pgulf/18k-a.html>*

**Cyclosarin** A nerve gas agent commonly referred to as GF, similar to sarin (GB) (see below), but more persistent.

*References: Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for Cyclosarin. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.*

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# Detection Paper

Detection paper is based on certain dyes being soluble in chemical warfare agents. Normally, two dyes and one pH indicator are used, which are mixed with cellulose fibers in a paper without special coloring (unbleached). When a drop of chemical warfare agent is absorbed by the paper, it dissolves one of the pigments. Mustard agent dissolves a red dye and nerve agent a yellow. In addition, VX causes the indicator to turn to blue which, together with the yellow, will become green/green-black.

Detection paper can thus be used to distinguish between three different types of chemical warfare agents. A disadvantage with the papers is that many other substances can also dissolve the pigments. Consequently, they should not be located in places where drops of, e.g., solvent, fat, oil or fuel can fall on them. Drops of water give no reaction.

On the basis of spot diameter and density on the detection paper, it is possible to obtain an opinion on the original size of the droplets and the degree of contamination. A droplet of 0.5 mm diameter gives a spot sized about 3 mm on the paper. A droplet/cm<sup>2</sup> of this kind corresponds to a ground contamination of about 0.5 g/m<sup>2</sup>. The lower detection limit in favorable cases is 0.005 g/m<sup>2</sup>.

*Reference: Detection of Chemical Weapons: An overview of methods for the detection of chemical warfare agents; homepage:*  
<http://www.opcw.nl/chemhaz/detect.htm>

# M256A1 Chemical Agent Detection Kit

The M256A1 kit is a portable, expendable item capable of detecting and identifying hazardous concentrations of chemical agent. The M256 kit is used after a chemical attack to determine if it is safe to unmask. The M256A1 kit has replaced the M256 kit. The only difference between the two kits is that the M256A1 kit will detect lower levels of nerve agent. This improvement was accomplished by using an eel enzyme for the nerve test in the M256A1 kit in place of the horse enzyme used in the M256 kit.

*Reference: Worldwide Chemical Detection Equipment Handbook, p. 430*

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M8A1  
Chemical  
Alarm

The M8A1 is an automatic chemical agent detection and warning system designed to detect the presence of nerve agent vapors or inhalable aerosols. The M8A1 will automatically signal the presence of the nerve agent in the air by providing troops with both a audible and visible warning. The M8A1 was fielded to replace the wet chemical M8 detector with a dry system which eliminated the M229 refill kit, the logistic burden and associated costs. The M8A1 operates in a fixed, portable, or vehicle mounted configuration.

*Reference: Worldwide Chemical Detection Equipment Handbook, p. 412*

Mustard

Mustard "gas" refers to several manufactured chemicals including sulfur mustard. They do not occur naturally in the environment. The term gas is in quotes because mustard "gas" does not behave as a gas under ordinary conditions. Mustard "gas" is really a liquid and is not likely to change into a gas immediately if it is released at ordinary temperatures. As a pure liquid, it is colorless and odorless, but when mixed with other chemicals, it looks brown and has a garlic-like smell. Mustard "gas" was used in chemical warfare and was made in large amounts during World Wars I and II. It was reportedly used in the Iran-Iraq war in 1984-1988. It is not presently used in the United States, except for research purposes.

The only way that mustard "gas" would enter the environment [other than through use as a weapon] would be through an accidental release. Some evaporates from water and soil into air. It does not easily go into water, and the amount that does breaks down quickly. It is more stable in soil than in water but still breaks down within days, depending on the outside temperature (cold weather makes it more stable). It does not go from soil to groundwater. Mustard "gas" does not build up in the tissues of animals because it breaks down so quickly.

Mustard "gas" makes your eyes burn, your eyelids swell, and causes you to blink a lot. If you breathe mustard "gas," it can cause coughing, bronchitis, and long-term respiratory disease.

*References: Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for mustard "gas." Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.*

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**Sarin**

Sarin is a light brown liquid. It is odorless, and evaporates about as fast as gasoline. It is toxic both as fumes and to the touch. It is not as persistent an agent as Tabun or Soman, the other two of the trinity of nerve gases developed in Germany.

Sarin, along with Tabun and Soman was invented not long before the Second World War by German scientist Dr. Gerhard Schrader. While developing insecticides similar to malathion and parathion, he discovered the first "nerve gas" agents, as they were then called. In 1936 he discovered Sarin. The Germans stockpiled these weapons during the Second World War, but never used them, probably because of Hitler's personal distaste for the weapons (he himself was a victim of gas attacks in Flanders during the First World War). Sarin is now known as "GB."

Only very small amounts of Sarin are needed to kill. A single milligram of Sarin coming in contact with the skin is sufficient to kill. In a vaporous form, it takes a concentration of 100 milligrams per cubic meter to be fatal. Nerve gases such as Sarin are known as "organophosphorus anticholinesterases" or "OP's." Their chemical method of killing is to block the enzyme cholinesterase. The body's muscles receive electrical impulses caused by choline. Cholinesterase break down choline, making sure these impulses stop at the proper time. Cholinesterase attaches itself to choline and breaks it down, thus halting the impulse. Sarin fools the cholinesterase into acting upon the Sarin as it would choline. When the cholinesterase attaches itself to Sarin, it doesn't break down. Thus, choline is not broken down, and the body goes into convulsions.

The first symptoms start in the eyes, where the pupils contract and vision is blurred. It causes breathing problems and chest tightness. Finally it produces vomiting and headaches, after which the heart and lungs stop as the body convulses. The antidote is a substitute for the missing cholinesterase, which is atropine.

The armed forces in the Gulf War were given Oxime tablets in case of gas attack, which acts to release cholinesterase from the Sarin.

*References: Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for Sarin. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.*

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UN Security  
Council  
Resolution  
687

This resolution was adopted by the UN Security Council at its 2981st meeting, on 3 April 1991. The pertinent section of this resolution, as related to the Khamisiyah report, follows:

6. Notes that as soon as the Secretary-General notifies the Security Council of the completion of the deployment of the United Nations observer unit, the conditions will be established for the Member States cooperating with Kuwait in accordance with resolution 678 (1990) to bring their military presence in Iraq to an end consistent with resolution 686 (1991);

Invites Iraq to reaffirm unconditionally its obligations under the Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and to ratify the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, of 10 April 1972;

Decides that Iraq shall unconditionally accept the destruction, removal, or rendering harmless, under international supervision, of:

(a) All chemical and biological weapons and all stocks of agents and all related subsystems and components and all research, development, support and manufacturing facilities;

(b) All ballistic missiles with a range greater than 150 kilometres and related major parts, and repair and production facilities;

Decides, for the implementation of paragraph 8 above [paragraph 6 is only numbered paragraph in document], the following:

(a) Iraq shall submit to the Secretary-General, within fifteen days of the adoption of the present resolution, a declaration of the locations, amounts and types of all items specified in paragraph 8 and agree to urgent, on-site inspection as specified below;

(b) The Secretary-General, in consultation with the appropriate Governments and, where appropriate, with the Director-General of the World Health Organization, within forty-five days of the passage of the present resolution, shall develop, and submit to the Council for approval, a plan calling for the completion of the following acts within forty-five days of such approval:

*Reference: UN Security Council Resolution 687, dated April 1991*

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**TAB B - Units Identified as Being Within a 50 Kilometer Radius of Khamisiyah ASP (4-15 March 1991)<sup>97</sup>**

The following tables shows those units, and reported total personnel strengths, which have been identified by investigators as being present during the demolition operations at Khamisiyah ASP;

<b>MAJOR COMMAND</b>	<b>UNIT DESIGNATION</b>	<b>PERSONNEL STRENGTH</b>
82nd Division (Airborne)	Hqs., 82nd Div	399
	Tactical Command Post (TAC), 1st Bde	122
	Tactical Operations Center (TOC), 3rd Bde	112
	1st Bn, 504th IN	757
	2nd Bn, 504th IN	794
	1st Bn, 505th IN	787
	2nd Bn, 505th IN	778
	3rd Bn, 505th IN	772
	4th Bn, 325th IN	774
	1st Bn, 319th FA	462
	2nd Bn, 319th FA	468
	1st Sqdn, 17th Air Cavalry	443
	3rd Bn, 73rd AR	596
	313th MI Bn	474
	307th Medical Bn	370
	307th EN Bn	498
	37th EN Bn	511
	450th Civil Affairs Bn	77
	Main Command Post, 24th IN Div	908
24th IN Division (Mech)	Hqs., 197th IN Bde	323
	2nd Sqdn, 4th Cavalry	404
	24th Signal Bn	668
	724th Combat Support Bn	855
	1st Bn, 5th ADA	635

<sup>97</sup> Based on locations reported for battalion-level Unit Identification Codes (UICs) derived from the Geographic Information System (GIS) [UIC-based personnel strengths from the Defense Manpower Data Center (DMDC).]

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<i>MAJOR COMMAND</i>	<i>UNIT DESIGNATION</i>	<i>PERSONNEL STRENGTH</i>
	Hqs., 36th EN Group	71
	3rd EN Bn	682
	5th EN Bn	807
	299th EN Bn	601
	362nd EN Co.	156
101st Airborne Division (Air Assault)	Rear Command Post, 2nd Bde	87
	Hqs., 101st Aviation Bde	146
	1st Bn, 320th FA	436
Other Units	2nd Sqdn, 3rd ACR	866
	Hqs., 265th EN Group	75
	Hqs., 937th EN Group	79
	12th EN Bn	747
	46th EN Bn	605
	264th EN Co.	98
	Tactical Command Post (TAC), XVIII Corps Artillery (Airborne)	219
	1st Bn 181st FA	443
	1st Bn, 623rd FA	411
	Hqs., 513th MI Bde	197
	Hqs., 12th Aviation Bde	146
	9th Chemical Co.	41
	36th Medical Detachment	58
	5th Mobile Army Surgical Hospital	150
	41st Medical Hospital	247
	47th Combat Support Hospital	234
	47th Field Hospital	284

Total ..... 20,867

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The following units have been identified to the IAD through contacts with commanding officers. The IAD is providing this information to a separate team whose focus is to verify unit locations :

### **24th Infantry Division (Mechanized)**

#### **1st Bde:**

HHC 1st Bde  
2/7th IN Bn  
3/7th IN Bn  
2/69th AR Bn  
1/41st FA Bn  
5th EN Bn  
24th Fwd Spt Bn

#### **2nd Bde:**

HHC 2nd Bde  
3/15 IN Bn  
1/64th AR Bn  
4/64th AR Bn  
3/41 FA Bn  
3rd EN Bn  
224th Fwd Spt Bn

#### **197th IN Bde:**

HHC 197th  
1/18th IN Bn  
2/18th IN Bn  
2/69th AR Bn  
4/41st FA Bn  
299th EN Bn  
324th Fwd Spt Bn

### **Division Support Command:**

#### **HHC & MMC, DISCOM**

724th Support Bn (Main)  
91st Chemical Co.  
327th Chemical Co. (DECON)  
197th Support Bn  
82nd Ordnance Det.  
83rd Ordnance Det.

#### **Medical:**

5th MASH  
2nd MASH  
10th MASH  
274th Field Surgical Team  
595th Medical Co.  
3/565th Medical Co. (AMB)  
47th Cbt Spt. Hosp.  
498th Air Ambulance Co.  
34th Medical Bn  
786 Medical Det. (KA)  
702nd Medical Co. (CLR)  
690th Medical Co. (AMB)

#### **171st Corps Support Group**

##### **260th QM Bn:**

110 Supply Co. (POL)  
84th Med. Truck Co. (Cargo)  
416th Med. Truck Co. (POL)  
542nd Maint. Co.  
24th Ordnance Co.  
851st S&S Co.

##### **548th S&S Bn:**

57th Med. Truck Co.  
1083rd Heavy Truck Co.  
514th Maint. Co.  
460th S&S Co.

##### **541st Maintenance Bn**

226th Maint. Co.  
632nd Maint. Co.  
991st Heavy Truck Co.  
133rd Ordnance Det.  
118th Ordnance Det.

THIS IS AN INTERIM REPORT,  
NOT A FINAL REPORT

**24th Aviation Bde:**

HHC 24th Avn Bde  
 1/24th Avn Bn  
 3/24th Avn Bn  
 1/58th Avn Bn (ATC)

**Division Artillery:**

HHC, DIVARTY  
 G-333 FA (TAB)

**212th FA Bde:**

2/17th FA Bn  
 2/18th FA Bn  
 3/27th FA Bn  
 C-25th FA (TAB)

**Division Troops:**

2/4th Cavalry Sqdn  
 124th Military Intelligence Bn  
 36th EN Group  
 362nd CSE Co.  
 264th MGB Co.  
 1/5th ADA Bn  
 24th Signal Bn

24th Military Police Co.  
 211th Military Police Co.  
 519th Personnel Service Co.  
 24th Finance Support Unit  
 422nd Civil Affairs Co.  
 Det. 300 Postal Co.  
 HHC Division

**1st Corps Support Command (COSCOM)**

46th Corps Support Group (CSG); assigned to the 82nd Div (ABN)  
 171st CSG; assigned to the 24th ID (MECH)  
 101st CSG; assigned to the 101st Div (AASLT)

*If you are aware of units or individuals who were within the 50-kilometer radius of Khamisiyah who are not listed above, please contact the DoD Persian Gulf Task Force Hot Line at 1-800-472-6719.*

THIS IS AN INTERIM REPORT,  
 NOT A FINAL REPORT

# **Information Paper**

## **The Fox NBC Reconnaissance Vehicle**

Information Papers are reports of what we know today about military, procedures and equipment used during the Gulf War of 1990 and 1991. This particular information paper focuses on the Fox NBC Reconnaissance Vehicle. The purpose of this paper is to give the reader a basic understanding of how the Fox works to facilitate understanding of cases involving the Fox. This is not an investigative report, but a vehicle to provide background information on a chemical detection device used in several cases currently being investigated. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the use of the Fox NBC Reconnaissance Vehicles during the Gulf War as well as specific incidents such as alarms and detections. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

Last Update: July 31, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War Illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1995 to investigate all possible causes of Gulf War Illness. On 12 November 1996, responsibility for these investigations was assumed by the Investigation and Analysis Directorate (IAD), Office of the Special Assistant for Gulf War Illnesses (OSAGWI) which has continued to gather information on the Fox NBC Reconnaissance Vehicle. Its interim report is contained here.

As part of the effort to inform the public about the progress of this effort, DoD is publishing on the Internet and elsewhere accounts related to possible causes of Gulf War Illnesses, along with whatever documentary evidence or personal testimony was used in compiling the account. The information paper that follows, which describes the Fox NBC Reconnaissance Vehicle used during the Gulf War, will aid in understanding incidents involving these vehicles.

## SUMMARY

The Fox Nuclear Biological and Chemical (NBC) Reconnaissance Vehicle was the most sophisticated and technically complex piece of chemical detection equipment that the US used in Operations Desert Shield and Desert Storm. "These vehicles were dedicated systems of NBC detection, warning, and sampling equipment integrated into a high speed, high mobility, wheeled, armored carrier capable of performing NBC reconnaissance on primary, secondary, or cross-country routes."<sup>1</sup> They were designed to provide an initial alerting mechanism to warn personnel of the possible presence of dangerous chemicals, and provide a detailed confirmation capability by means of on-board mass spectrometers. These vehicles were state-of-the-art chemical reconnaissance systems and a quantum leap in technology over existing US capabilities. Other detection equipment aboard the Fox include the M43A1 Chemical Agent Detector, the M256 Series Chemical Agent Detector Kit, the AN/VDR2 radiation detector, and the ASG1 radiation detector. However, the Fox did not provide a biological detection capability. The Fox vehicle was used according to the context of each military operation. Tactics associated with an operation often restricted the operation of the Fox vehicle to less than its full capability to detect chemical agents.

The Fox was designed as a reconnaissance system, with a primary function to detect, identify, and mark persistent ground contaminated areas. Although it could detect chemical warfare agent vapors, the basic Fox with its MM-1 mass spectrometer was not optimized for this purpose. During Operation Desert Storm, the Fox was used as a reconnaissance vehicle, as a mobile vapor detector, and as a spot detector to confirm detections from other equipment. The Fox with its MM-1 performed a quick survey check for the presence of chemicals chosen as the most likely to be present. If an alert occurred during this quick survey, a more time-consuming spectrum was necessary for confirmation. During Operation Desert Storm, interfering chemicals such as oil well fire smoke posed difficulties for the Fox's detection capabilities.

The following paper gives a more technical and in-depth explanation of the Fox Vehicle, how it detects chemicals, its capabilities, and its use during Operation Desert Storm.

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<sup>1</sup> NBC Reconnaissance Squad/Platoon (Fox) Operations, US Army Field Manual 3-101-2, Chapter 2, 10 August 1994.



## BACKGROUND

The first American experience with chemical warfare was during World War I. The US military suffered numerous casualties because they were unprotected and had no warning. The first US Automatic Chemical Alarm, the M8, was fielded in the late 1970s and was replaced by the M8A1 in the mid-1980s. The Chemical and Biological Defense Command (CBDCOM) and the Army Training and Doctrine Command (TRADOC) initiated a Concept Exploration Program in 1984 to establish the feasibility of a mobile NBC Reconnaissance system. The program tested a German Fuchs and a prototype mounted on an M113 Armored Personnel Carrier. In September of 1986 it was decided to explore the feasibility of leasing 48 German Fuchs systems to satisfy the needs of the US Army Europe (USAEUR). In October 1987 the Vice Chief of Staff of the Army and the Undersecretary of the Army decided to buy 48 German systems to fulfill the USAEUR need. In February 1988 the Vice Chief of Staff of the Army and the Undersecretary of the Army decided to cancel the M113 program and purchase the Fuchs for fielding world-wide. General Dynamics was awarded a contract to manufacture an American version of the German Fuchs NBC Reconnaissance System (NBCRS) in March of 1990.<sup>2</sup>

During Operation Desert Shield and just prior to Operation Desert Storm, the government of Germany provided the United States with 60 Fuchs NBC Reconnaissance Vehicles.<sup>3</sup> These 60 vehicles were modified prior to delivery by adding English language labels and software, a M43A1<sup>4</sup> Chemical Agent Detector, air conditioning, and US radios. These "Americanized" variants became known as the XM93 "Fox" vehicle.<sup>5</sup>

The purpose of this paper is to provide a basic understanding of how the Fox Vehicle works, its capabilities and limitations, and how it was used during Operation Desert Storm.



Figure 1. XM93 Fox Reconnaissance Vehicle

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<sup>2</sup> Information paper written by Subject Matter Experts from CBDCOM, Edgewood, MD.

<sup>3</sup> The first vehicle arrived in the Persian Gulf in late September 1990 and the last vehicles arrived in the middle of February.

<sup>4</sup> The M43A1 chemical detector when combined with the M42 alarm forms the M8A1 Automatic Chemical Agent Alarm.

<sup>5</sup> The X as in the nomenclature XM93, usually designates an item as experimental. When the US received 60 Foxes from the Germans, the Army had already tested the vehicle and was in the process of purchasing 48 vehicles. In this case, the X denotes that this vehicle had not yet been type-classified by DOD.

## DESCRIPTION

The Fox Vehicle is a six-wheeled, light armored, NBC Reconnaissance Vehicle. On-board NBC detection capabilities include the MM-1 Mobile Mass Spectrometer, which is the primary detection device, the M43A1 Chemical Agent Detector, the M256 Series Chemical Agent Detector Kit, the AN/VDR2 radiation detector, and the ASG1 radiation detector.<sup>6</sup> The Fox does not provide any biological detection capability, but does protect the crew from biological hazards, and allows the crew to mark areas of potential hazard and safely take samples for laboratories to analyze for biological hazards. With these capabilities, the Fox vehicle was used according to the context of each military operation. Tactics associated with each type of operation often restricted the operation of the Fox vehicle and reduced its capability to detect chemical hazards. For instance, troops performing offensive operations need to move quickly to exploit the momentum of the assault and reduce troop and equipment losses from enemy fire.

There are also several considerations about the Fox vehicle that should be understood before drawing any conclusions about chemical detections or alarms reported during Operation Desert Storm. First, the Fox was designed as a reconnaissance system, with a primary function to detect, identify, and mark persistent ground contaminated areas. Although it can detect chemical warfare agent vapors, the basic Fox with its MM-1 mass spectrometer is not optimized for this purpose and is significantly less effective than existing chemical vapor detectors, (such as the M43A1). For this reason the M43A1 was added to the Fox vehicle. Second, the Fox has a two-step alert and confirmation process.<sup>7</sup> It makes an initial quick scan for possible chemical presence to provide maximum warning to troops. This may cause false alarms. The second step is a more time-consuming analysis that can more precisely identify what chemicals are present. Third, the Fox cannot determine the specific concentration of a chemical agent. It has a mass spectrometer (the MM-1) that can identify what chemicals are present, but not how much is present. Fourth, recording many MM-1 actions and results (such as the outcome of a spectrum) on a Fox tape requires additional, time-consuming steps on the part of the operator.

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<sup>6</sup> In addition to these detectors, the M21 infrared detector will be added to many of the Foxes to provide stand-off chemical agent detection.

<sup>7</sup> MM-1 User Manual, Bruker-Franzen Analytik GmbH, copyright 1987.

#### GERMAN NBC RECON SYSTEM

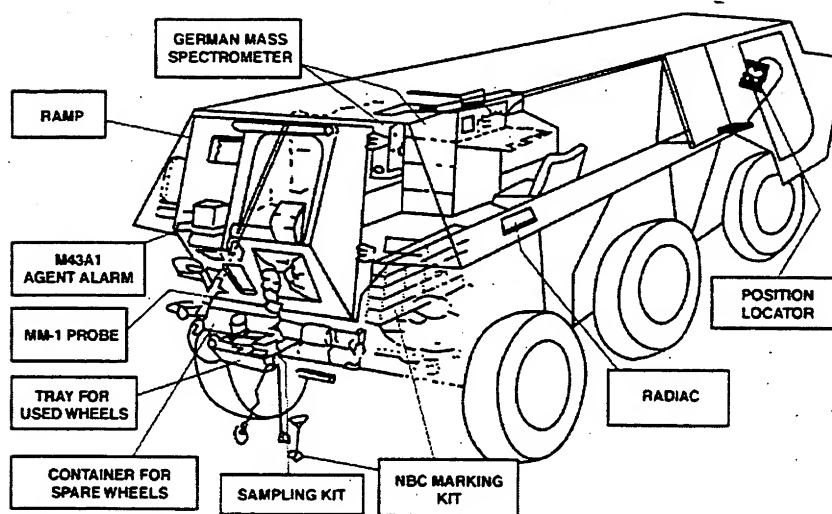


Figure 2. Fox Reconnaissance Vehicle

The Fox can conduct NBC reconnaissance and chemical agent detection on the move. It can keep up with maneuver forces at a pace of 30-40 km/h using several methods of operation. This allows it to cover large areas. The Fox provides both "real time" alerting and detailed confirmation of chemical agents during offensive and defensive maneuver operations. The Fox crew is protected from outside contamination by pressurizing and sealing the vehicle. This allows the crew to conduct NBC reconnaissance, retrieve and retain samples, and mark contamination boundaries without leaving the vehicle or wearing chemical protective equipment. The on-board air conditioner increases crew comfort and keeps electronic equipment from overheating. The heart of the Fox vehicle detection system is the MM-1 Mobile Mass Spectrometer which can detect and identify chemical agents that have been preprogrammed into its library. The chemicals programmed into the library are chosen based on the suspected chemical threat.

#### The MM-1 Mobile Mass Spectrometer

The MM-1 Mobile Mass Spectrometer is a tool used to analyze chemical compounds. All chemical compounds are made up of small pieces called "molecules." A mass spectrometer excites each molecule, breaking it into smaller charged particles called "ions," and then counts each ion in a sample. These ions are sorted by their atomic weights, providing a unique signature for each chemical substance. The MM-1 graphically displays the relative intensities of selected ion patterns to the operator's screen. A spectrum is a listing of the relative intensity of each ion the mass spectrometer counted for the molecules in the sample. Additionally, this information can be printed to a hard copy tape for later, more detailed analysis and a record of the detection. Since a spectrum for each chemical taken under the same conditions is unique, using a mass

spectrum to identify a chemical substance is similar to identifying a person by using a fingerprint.

Because the MM-1 can detect only relative intensities and not concentrations or amounts, it requires a baseline spectrum of air taken in an uncontaminated area. This baseline spectrum, called a background, is taken upon starting up the equipment, whenever a change in methods occurs and periodically while in use. The minimum detectable amount for each ion mass is calculated from the background.<sup>8</sup> All subsequent readings the MM-1 makes are compared to that background.

### *Taking a Sample*

When a substance contacts the sampling port, as shown in Figure 3, the sampling port heats it until the substance vaporizes. Because many different chemical compounds may be in the vaporized sample, it is important to separate them so they can be identified. As the vaporized sample travels through the sampling probe, it separates due to temperature and because lighter molecules travel faster than heavier molecules. The MM-1 can operate at two different temperatures: the Hi temperature of 180° C, and the Lo temperature of 120° C. When the probe is hot (Hi temperature), all the molecules travel fast and there is less separation. If the probe is less hot (Lo temperature), the molecules travel slower and there is more separation. After the vaporized sample molecules are separated traveling up the probe, they enter the MM-1 where they are broken into smaller charged pieces called ions, which the MM-1 uses to identify the substances in the sample and the relative-intensity of each substance. It is important to note that when the MM-1 takes a spectrum it analyzes only the substance with the highest relative intensity, even if several substances are present.<sup>9</sup>

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<sup>8</sup> The minimum detectable amount is three times the square root of the average background.  $3 \times (\text{average background})^{1/2}$ .

<sup>9</sup> The MM-1 has the capability to analyze each substance by following a procedure known as a series spectrum. However, US operators were not trained to perform series spectra so this paper does not describe the process.

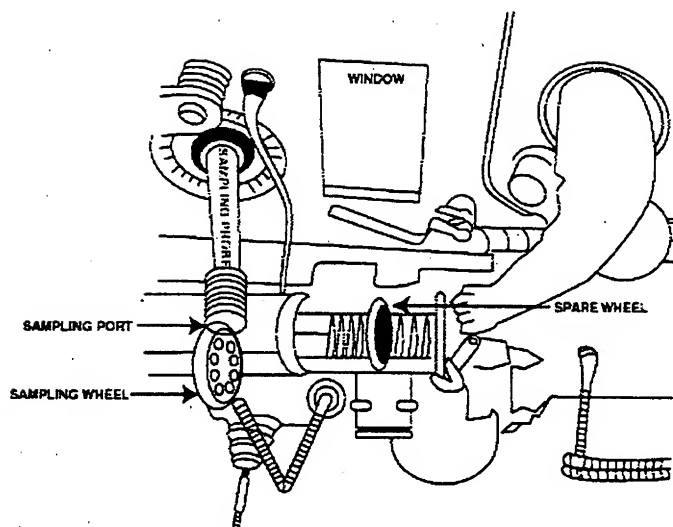


Figure 3. Close-up view of the back of the Fox Vehicle

The MM-1 can operate in two modes, each with multiple methods, but US troops were only trained in the Air Monitor Mode of operation.<sup>10</sup> Consequently, this paper only addresses the Air Monitor surveillance mode. Three methods of detection were used to search for chemicals during Operation Desert Storm. These methods were Wheel/Hi, Air/Hi, and Surface/Lo. Table 1 shows the temperature and sampling probe position for each of the methods.

Table 1. Methods

Mode	Method	Probe Temperature	Wheels Used	Probe Position
Air Monitor	Wheel/Hi	Hi 180° C	Yes	2-3 feet from ground
	Air/Hi	Hi 180° C	No	2-3 feet from ground
	Surface/Lo	Lo 120° C	No	2-4 inches from ground

### *The Wheel/Hi Method*

The Wheel/Hi method is designed to alert the crew to the possible presence of a liquid chemical warfare agent. The Wheel/Hi method uses two sampling wheels which trail behind the Fox to pick up liquid chemical samples from the ground. The wheels lift alternately to the probe's sampling port where the liquid present on the wheels is vaporized by the heat of the sampling port. During Operation Desert Storm, the wheels did not lift automatically; a Fox crew member

<sup>10</sup> In the Air Monitor Mode, the MM-1 continuously monitors for chemical agents until the operator directs the MM-1 to perform more specialized analysis (e.g. taking a spectrum). The Surface Monitor Mode performs one cycle of several measurements. At the end of this cycle, the process would have to be started again by the MM-1 operator. The resultant data from the Surface Monitor Mode required additional scientific interpretation by the MM-1 operator. For simplicity and the continuous monitoring capability, the Air Monitor Mode was the only mode authorized for use by US Fox crews.

had to manually push a switch each time a wheel needed lifting to take a sample. If the wheels were not lifted, the probe still sampled the surrounding air, which was effectively the Air/Hi method.

### *The Air/Hi Method*

The Air/Hi method does not use the sampling wheels but is otherwise similar to the Wheel/Hi method. The Air/Hi method can detect only chemical vapors in the surrounding area. According to the chemical engineers at the US Army's Chemical and Biological Defense Command, Edgewood, Maryland (experts in the system performance and capabilities), the Fox is not well suited for generalized vapor detection, because the air volume drawn through the sampling probe is approximately 300-400 times less than the air volume drawn through other detectors such as the M43A1. The result is that the MM-1 is approximately 500 times less sensitive to nerve agent vapors than the M43A1<sup>11</sup>. Consequently, when the Fox was modified for American use, the M43A1<sup>12</sup> was added as a vapor detector. Table 2 shows the vapor sensitivities of the MM-1 as compared to other vapor detectors.

Table 2. Vapor Chemical Agent Detector Characteristics<sup>13</sup>

Item	Agents	Sensitivity	Response Time
M8A1 Alarm	G, V Nerve	0.1-0.2 mg/m <sup>3</sup>	<=2 min
M256A1 Kit	G	0.005 mg/m <sup>3</sup>	15 min
	V	0.02 mg/m <sup>3</sup>	15 min
	H	2 mg/m <sup>3</sup>	15 min
	L	9 mg/m <sup>3</sup>	15 min
	CX	3 mg/m <sup>3</sup>	15 min
	CK	8 mg/m <sup>3</sup>	15 min
	AC	9 mg/m <sup>3</sup>	25 min
CAM	GA, GB, VX, HD, HN	<= 0.1 mg/m <sup>3</sup>	<=1 min
MM-1 <sup>14</sup>	GB <sup>15</sup>	62 mg/m <sup>3</sup>	<=45 sec
	CK	46 mg/m <sup>3</sup>	
	CG	115 mg/m <sup>3</sup>	

<sup>11</sup> The M43A1 can detect as little as 0.2 mg/m<sup>3</sup> of G agent vapor, while the MM-1 requires at least 100 mg/m<sup>3</sup>.

<sup>12</sup> A technical discussion of the M43A1 Chemical Agent Detector can be found in the M8A1 Automatic Chemical Agent Alarm Information Paper due for release September 1997.

<sup>13</sup> Report of the Defense Science Board Task Force on Persian Gulf War Health Effects; June 1994 Table 18.

<sup>14</sup> Because the minimum detectable amount is calculated from the background and backgrounds vary dependent on environmental and atmospheric conditions the minimum detectable amounts will vary. The sensitivities listed in Table 2 are relevant only for the specific conditions they were calculated from.

<sup>15</sup> At this level unprotected personnel would experience symptoms from Sarin before the MM-1 would alert.

### *The Surface/Lo Method*

The Surface/Lo method uses the lower operating temperature (120° C) allowing the maximum amount of separation among multiple chemical compounds. Surface/Lo is the recommended method to take a spectrum (but a spectrum could be taken from any method). After the MM-1 alerts for a chemical agent, the normal operating procedure is for the operator to stop the vehicle, change the method to Surface/Lo, and wait for the probe to cool from 180° to 120° C. The MM-1 requires at least three minutes to cool the probe temperature from Hi to Lo. The operator then lowers the sampling probe until it is approximately 2-4 inches from the suspected contamination, takes another sample, and performs a spectrum. All of this takes time and in several operational scenarios such as the Marine breaching operations, the confirmation procedure (taking a spectrum) could not be performed without interfering with the accomplishment of the primary mission. Therefore, confirmation was not done.

### *The Initial Search For Chemical Agents*

Regardless of the method being used, a quick response time is paramount to the safety of troops involved in military operations. In order to provide the response time necessary for military operations, the MM-1 continuously monitors against a target list<sup>16</sup> of approximately 10 selected chemical agents most likely to be present, based on intelligence reports and the suspected chemical threat. The 10 chemicals usually on the target list were:

- TABUN (GA)
- SARIN (GB)
- SOMAN (GD)
- VX (VX)
- S-MUSTARD (HD)
- LEWISITE (L)
- PHOSGENE (CG)
- HYDROCYANIC ACID (AC)
- CYCLOSARIN (GF)
- FAT, OIL, WAX

To speed the initial search, the MM-1 looks for only four ion peaks for each chemical and attempts to match the pattern and ratio of these peaks against the target list of chemicals. If an initial match is made with these four ion peaks, the MM-1 sounds an alarm. However, this first alarm does not confirm the presence of a chemical agent since there are many chemical "interferents" that have similar ion peaks and many combinations of chemicals that may yield ion patterns similar to those in the target list. Consequently the MM-1 can falsely indicate the

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<sup>16</sup> The entire 60 substance chemical library programmed into the Fox vehicle during Operations Desert Shield and Desert Storm is shown in Tab C.

presence of dangerous chemicals . For example, the four ion peaks used to initially alert for the nerve agent Sarin and the riot control agent CS are similar. Additionally, Sarin has an ion peak at 125.0 molecular weight (m.w.) and a relative intensity of 25.0%, while the riot agent CS has an ion peak at 126.0 m.w. with a relative intensity of 18.7%. Because this peak in particular is so similar, the MM-1 may initially alert for Sarin when the actual chemical is CS resulting in a "false positive" for Sarin.

A "false positive" is an initial alert for a dangerous chemical that is not present. To positively determine what chemical is present, the MM-1 operator must run a spectrum to analyze all the ions present, not just the four used in the initial alert. The spectrum of the suspected chemical is compared to all the detection algorithms stored in the MM-1 chemical library. If a match is found, the MM-1 confirms the initial alert. If a match is not found, the MM-1 displays "unknown." For later analysis and a permanent record of the alarm, the complete ion spectrum by atomic weight can be printed on the Fox tape; however, this is a manual function that the operator must perform and is not an automatic feature of the system.

### *Minimizing Alarm Errors*

Since not alerting to a chemical agent seriously jeopardizes the safety of unprotected troops, the Fox has been specifically designed to ensure an alert occurs if a substance is present at the expense of generating potential false alarms. This ensures maximum warning time and safety. However, so the Fox is not continuously alerting to a variety of substances, there are several design considerations to minimize the "false positives." The MM-1 uses mathematical algorithms to reduce "false positives" while assuring an alarm is generated if a chemical warfare agent is present. The algorithms depend on three compound-specific values to separate genuine alarms from alarm errors. These values are the Interference, Reliability, and Impossible Ion parameters, and they may be uniquely set for each compound in the library. An example of these values is shown in Table 3; a complete list is provided at Tab C.

Table 3. Examples of Parameter Values

<b>Chemical</b>	<b>Interference Parameter</b>	<b>Reliability Parameter</b>	<b>Impossible Ion by Molecular Weight</b>
SARIN	8.0	3.0	
CS	1.0	3.5	
PHOSGENE	2.0	3.0	109 m.w.
CYCLOSARIN	8.0	3.5	97 m.w.
S-MUSTARD	8.0	3.0	
LEWISITE	8.0	3.0	

In general, the function of the interference parameter is to suppress alarms when large amounts of interfering substances are present. Larger values mean a higher amount of an interfering



compound is required to suppress an alarm. The scale is logarithmic so a chemical warfare agent with an interference parameter of 1.0 would require the interfering compound to have only ten times the amount before the alarm would be suppressed. The alarm for a chemical warfare agent with an interference parameter of 8.0 (like Sarin) would only be suppressed if the presence of the interfering agent were 100,000,000 ( $10^{8.0}$ ) greater. By properly setting the interference parameter, one can assure that the MM-1 alarms for the presence of a small amount of chemical warfare agent in the presence of a large amount of other compounds. The value of the interference parameter is preprogrammed into the MM-1 and is determined by experience and testing.

Table 4 provides examples of chemicals whose ion patterns in certain conditions are known to resemble those of chemical warfare agents. The Sarin-CS similarity was mentioned earlier. In subsequent Fox vehicle testing after the war,<sup>17</sup> it was determined that the silicone material in the Fox sampling wheels and silicone lubricants on the wheels would emit certain ions when raised to the heated sampling probe. These ions could confuse the MM-1, causing an initial alert for the chemical warfare agent Lewisite. A detailed spectrum analysis would indicate that the alarm is in fact a "false positive" by displaying "unknown" to the MM-1 operator. Although this was discovered after the Gulf War, it is relevant to the Fox vehicle configuration during the war and is a factor in explaining several of the alerts to the chemical agent Lewisite, which were never confirmed. Benzyl Bromide (a tear-producer and skin irritant) was not routinely monitored by the MM-1 but was in the Fox Chemical Library and could be identified by spectrum analysis. The ions used to identify Benzyl Bromide are also found in Toluene (a common solvent) and Cyclopentadiene (an insecticide).

Table 4 Examples of Interfering Agents<sup>18</sup>

Chemical Warfare Agent	Interfering Agent
Sarin	CS <sup>19</sup>
Lewisite	Silicone Plasticizers <sup>20</sup>
Benzyl Bromide <sup>21</sup>	Toluene <sup>22</sup> (solvent) and Cyclopentadiene (insecticide)

<sup>17</sup> Memorandum from the Office of the Program Manager for NBC Defense Systems, Subject: Results of the Combat Systems Test Activity (CSTA) MM-1 Excursion Test, 14 July 1993.

<sup>18</sup> This table does not include all the interfering agents for every chemical in the Fox chemical library. A notable addition to this list is oil well smoke which produces ions that are present in a number of chemical agents.

<sup>19</sup> Report from Bruker Analytical Systems, Inc., Subject: Analysis of MM1 Data for Sarin False Alarm and CS identification, 2 October 1996.

<sup>20</sup> Ember, Lois R. "Chemical Warfare Agent Detectors Probe the Fogs of War." C&EN, 1 August 1994: 26-32

<sup>21</sup> Not a chemical warfare agent but is considered a dangerous chemical and was included in the Fox chemical library.

<sup>22</sup> Letter from Richard Vigus, Subject Matter Expert, CBDCOM, Edgewood, MD, 12 November 1993.

The reliability parameter allows a range of variation among the four initial ion intensities monitored and is predetermined to give greater latitude to detect a chemical warfare agent. Determination of this parameter is a tradeoff between detection of an actual agent and generating a "false positive." The higher the setting, the more likely a "false positive" could occur.<sup>23</sup> This parameter was programmed into the MM-1 and pre-set by technicians prior to Operation Desert Storm, based upon the suspected chemical threat.

An impossible ion is an ion that is NOT present in a dangerous compound, but is present in another compound with similar peaks. If the MM-1 detects the impossible ion, it can determine the suspected chemical is not the dangerous compound being sought. For example the four peaks monitored for Phosgene are 65.0, 63.0, 98.0, and 109.0. The mass 109.0 is an impossible ion for Phosgene and is set with a relative intensity of 0.0%. If the MM-1 detects the mass 109.0 at any relative intensity other than 0.0%, the MM-1 would know the chemical could not be Phosgene, and it would not alert to Phosgene.<sup>24</sup>

Given the manner in which the MM-1 initially alerts for chemical agents and the parameter settings used to prevent alarm errors, it is possible to understand how the MM-1 could initially alert for a dangerous chemical when only a less hazardous substance is present. In a multi-chemical environment<sup>25</sup> such as a battlefield, the MM-1 must compare the ions encountered with the ion patterns of the chemical warfare agents on the target list. Because the percentage of each ion in a sample may vary slightly, the MM-1 allows for variation (plus or minus) on either side of the ion relative intensities programmed for each chemical. In the case of chemicals with similar ion peaks well within the variation allowed by the reliability parameter, safety considerations dictate that the MM-1 choose the more dangerous chemical. The interference parameter also forces the MM-1 to choose the more dangerous chemical by requiring such an enormous amount of the less dangerous chemical be present. In other words, if there is any question about the identity of the suspected substance, safety considerations require the MM-1 to alert for the dangerous chemical.

### *The Fox Tapes*

Every time the MM-1 performs a function, it can be recorded on a paper tape that looks similar to a grocery receipt. The printed tape records information such as calibration tests, alarms, warnings, method changes, and the results of spectrum analyses. If enabled, the autoprnt function prints everything automatically; otherwise the MM-1 operator must press the print button to record.

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<sup>23</sup> MM-1 User Manual, Bruker-Franzen Analytik GmbH, copyright 1986 pp. 6-10 through 6-12.

<sup>24</sup> Letter from Subject Matter Expert, CBDCOM, Edgewood, MD.

<sup>25</sup> Any place other than the controlled environment of a laboratory may be a multi-chemical environment.

Following are four examples<sup>26</sup> of possible MM-1 tapes. Listed first on all four tapes is the word "background," which prints every time the MM-1 changes detection methods. Below "background" the detection method being used to monitor for chemical agents is printed (e.g. Wheel/Hi or Air/Hi). All four examples have Air Monitor printed on them. This is the mode of operation US troops were trained to use. The next item on the tapes is location information and is based on data provided by the crew at the start of a mission and updated throughout the mission. The compound initially detected and its relative intensity appear on the line below the location. The letter<sup>27</sup> preceding the relative intensity denotes the detection method being used.

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<sup>26</sup> MM1 Detection Scenarios, CBD COM, Edgewood, MD.

<sup>27</sup> For example, the letter A shows the MM1 is not using the wheels. The letter C shows the wheels are in use.

In the first example, the MM-1 initially alerts to compound A with a relative intensity of 6.3. The MM-1 operator switches the MM-1 to the Surface/Lo method. Surface/Lo is printed on the tape. The MM-1 again alerts to compound A with a relative intensity of 6.4. Because the relative intensity is above 4.0, the MM-1 operator runs a spectrum. The spectrum confirms a detection for compound A.

BACKGROUND VCWA WHEEL/HI		
-----		
AIR MONITOR		
	4586/7123	
COMPOUND A	C 6.3	
	10:14 10	
COMPOUND A	C 6.3	
BACKGROUND CWA SURFACE/LO		
BACKGROUND V CWA SURFACE/LO		
	10:17 11	
COMPOUND A	A 6.4	
	10:18 12	
SPECTRUM		
COMPOUND A	S 3.8	
-----		
SPECTRUM		
	12/19/96	10:18
2	50	30.6%
4	69	100.0%
6	84	22.7%
9	100	44.9%
10	119	40.9%
11	131	45.9%
12	169	33.5%

Figure 4. Example 1 of a Fox Tape

BACKGROUND VCWA WHEEL/HI		
-----		
AIR MONITOR		
	4586/7123	
COMPOUND B	C 6.3	
	10:14 10	
COMPOUND B	C 6.3	
BACKGROUND CWA SURFACE/LO		
BACKGROUND V CWA SURFACE/LO		
	10:17 11	
COMPOUND B	A 6.4	
	10:18 12	
SPECTRUM UNKNOWN	S 3.8	
-----		
SPECTRUM		
	12/19/96	10:18
2	50	30.6%
4	69	100.0%
6	84	22.7%
9	100	44.9%
10	119	40.9%
11	131	45.9%
12	169	33.5%
13	177	6.1%
14	179	3.5%
14	182	4.7%
16	191	12.8%
17	192	3.9%
18	193	4.3%
19	207	65.9%

Figure 5. Example 2 of a Fox Tape

In the second example, the MM-1 initially alerts for compound B with a relative intensity of 6.3. The MM-1 operator switches to Surface/Lo and the MM-1 again alerts for compound B with a relative intensity of 6.4. A spectrum is run, but this time the spectrum does not match any of the compounds in the chemical library. The computer classifies the substance as "unknown" which means the chemical is not in the MM-1's library, and therefore is not compound B. If the substance is not in the library, the MM-1 has no basis of comparison, and thus can not determine if the substance is hazardous.

In the third example, the MM-1 initially alerts for compound C with a relative intensity of 6.3. The MM-1 operator switches to Surface/Lo. Compound C is detected again with a relative intensity of 6.4. A spectrum identifies the substance as FATS/OILS/WAXES. The MM-1 has detected hydrocarbons, not a chemical warfare agent.

BACKGROUND VCWA WHEEL/HI		
AIR MONITOR		
	4586/7123	
COMPOUND C	C 6.3	
	10:14 10	
COMPOUND C	C 6.3	
BACKGROUND CWA SURFACE/LO		
BACKGROUND V CWA SURFACE/LO		
	10:17 11	
COMPOUND C	A 6.4	
	10:18 12	
SPECTRUM		
Fats/Oils/Waxes	S 3.8	
SPECTRUM		
	12/19/96	10:18
2	47	6.8%
3	50	14.9%
4	51	13.1%
5	55	22.8%
6	63	6.4%
7	69	4.9%
8	73	100.0%
9	78	6.7%
10	81	3.5%
11	85	49.4%
12	89	5.9%
13	92	7.7%
14	95	9.9%
15	101	5.2%
16	183	4.7%

Figure 6. Example 3 of a Fox Tape

In the last example, the Air/Hi method is being used. The MM-1 initially alerts to compound D with a relative intensity of 1.9. The MM-1 operator switches to Surface/Lō and compound D is no longer being detected. The alarm is therefore not a confirmed detection.

BACKGROUND VCWA AIR/HI	
AIR MONITOR	
	4586/7123
COMPOUND D	A 1.9
	10:14 10
COMPOUND D	A 1.5
BACKGROUND CWA SURFACE/LO	
BACKGROUND V CWA SURFACE/LO	
	10:17 11
NO ALARM	

Figure 7. Example 4 of a Fox Tape

## Operational Employment During Operation Desert Storm

There were three basic ways the Fox was used during Operation Desert Storm: as a reconnaissance tool, as a mobile detector, and as a point detector. Following a text-book approach for a reconnaissance mission, the Fox drove across an area where troops and equipment had to pass. The Fox operated using the Wheel/Hi method.<sup>28</sup> The MM-1 was programmed to send a warning<sup>29</sup> if a chemical agent was detected above a predetermined relative intensity and alarm at a second higher predetermined relative intensity. If the MM-1 alerted to a chemical warfare agent, the MM-1 operator changed to the Surface/Lo method. This required that the Fox vehicle stop, allow the probe temperature to cool 60 degrees, and back up to the contaminated area if the vehicle's momentum carried it beyond the area to be tested. This process can take 5-10 minutes. The MM-1 operator runs a spectrum if the MM-1 continues to alert to a chemical

<sup>28</sup> NBC Reconnaissance Squad/Platoon (Fox) Operations, US Army Field Manual 3-101-2, pg. 5-2, 10 August 1994.

<sup>29</sup> The MM1 was programmed to issue a warning at a logarithmic relative intensity value of 0.6 and alarm at a logarithmic relative intensity value of 0.9 for every chemical in the Chemical Library. The relative intensities are based on the background readings taken at the start of the mission.

warfare agent and the relative intensity is high enough.<sup>30</sup> Only a spectrum analysis can positively identify the chemical in question. If the spectrum analysis identifies a chemical warfare agent, the Fox moves back to the edge of contamination. The MM-1 operator then switches to the Air/Hi method and moves around the boundary, watching for low ion level readings on the MM-1 screen. When the readings become very low, the MM-1 operator switches to the Surface/Lo method and takes another reading. The switching between Air/Hi and Surface/Lo continues until the boundaries of contamination are identified and marked.

If vapor agents were expected or if the operational considerations prevented the Fox from stopping, the Fox was used as a vapor detector. However, the Fox is not a very sensitive vapor detector and, therefore, not a good system for determining areas of vapor contamination. When operating as a mobile vapor detector, the procedures were similar to a reconnaissance mission except the Fox crews drove through areas using the Air/Hi method, sampling the airborne vapors. If a Fox initially alerted to a chemical warfare agent using the Air/Hi method, the MM-1 operator could switch to Surface/Lo and initiate a spectrum. However, operational considerations (such as exposure to enemy fire) often prevented the Fox crews from stopping and performing these important secondary functions. However, the initial alert from a Fox vehicle was enough cause for troops to don additional protective gear.

The Fox is a capable point detector, and was used this way during Desert Storm when a small area was suspected to be contaminated. The MM-1 used the Surface/Lo method with the probe lowered until it touched the unknown substance. The MM-1 operator would run a spectrum to identify the substance. In this way, the MM-1 could analyze compounds on individual pieces of clothing or equipment.

### **Observations from Desert Storm**

Commanders and Fox vehicle operators generally praised the operation of the Fox during Operation Desert Storm. "The Fox Reconnaissance vehicle proved valuable to commanders by rapidly confirming that agents were not present."<sup>31</sup> However, there were a couple of complaints, none of which hamper actual operations.

- "The VOS [Vehicle Orientation System] is absolutely useless for extended off-road use with no opportunity to update location. On moves of 10 km or less, accuracy was usually within 300m. On moves of 50 km, location accuracy was often off by as much as 20 km."<sup>32</sup> The VOS provides location information based on the inertia of the vehicle. Simply stated the VOS calculates current locations by using the starting coordinates, the direction of travel, and the number of wheel rotations counted during the vehicles movement. The problem with the VOS occurs when a vehicle's wheels

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<sup>30</sup> NBC Reconnaissance Squad/Platoon (Fox) Operations, US Army Field Manual 3-101-2, pg. 5-2, 10 August 1994

<sup>31</sup> Marine Corps NBC Defense in South West Asia, Marine Corps Research Center, Research Paper #92-0009

<sup>32</sup> After Action Report on Fuchs NBCRS.



rotate but the vehicle does not actually move. This situation can occur if the vehicle is trying to traverse areas where loose sand is prevalent.

- "Sampling wheel arms need to be spring loaded to allow the use of sampling wheels in rough off road use. Currently large bumps and ridges will damage the sampling arms."<sup>33</sup>
- "The Fox was ineffective in monitoring for agents through the breach because: it could not slow down to get good readings, it could not stop in the breach and take samples, and it was not allowed to go back and check breach areas that were thought contaminated."<sup>34</sup>
- "Almost all maintenance jobs require 'special tools' which were not available to our mobile maintenance teams. ... The Filters and other parts required for regular services were difficult to obtain, and often unavailable ...."<sup>35</sup>

The smoke from oil well fires was a problem for all the US chemical detection equipment. Crude oil combustion forms many ions that are also present in various chemical agents. Other environmental effects that caused the Fox to initially alert to several chemical agents included diesel fumes, and fumes from explosives. When the first Fox vehicles arrived in the Gulf, the fine sand in this region desert caused a detection problem for the Fox, but it was corrected prior to the start of the ground war.

## Conclusion

The Fox vehicle is a powerful tool for detection of chemical warfare agents and was first introduced to US troops during Operation Desert Storm. In order to improve troop safety and assure alerting for chemical warfare agents, the US government accepted the possibility of increased frequency of "false positives" occurring. Critical design considerations allowed for initial false alerts that could not be confirmed in many situations, but comments from commanders and Fox operators were very favorable of the vehicle. Planned improvements, due to input from commanders and Fox crews include the installation of the Global Positioning System (GPS) and the addition of the M21 stand-off chemical detector.<sup>36</sup>

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<sup>33</sup> After Action Report on Fuchs NBCRS.

<sup>34</sup> Marine Corps NBC Defense in South West Asia, Marine Corps Research Center, Research Paper #92-0009.

<sup>35</sup> After Action Report on Fuchs NBCRS.

<sup>36</sup> A stand-off chemical detector is a device that alarms to the presence of chemical agents without being located within the contamination.

## TAB A-ACRONYMS

CBDCOM	Chemical and Biological Defense Command
CEP	Concept Exploration Program
CPU	Central Processing Unit
CS	o-chlorobenzylidene Malononitrile
KKMC	King Khalid Military City
IAD	Investigation and Analysis Directorate
MM-1	Mobile Mass Spectrometer
MMT	Mobile Maintenance Team
MOS	Military Occupational Skills
m.w.	Molecular Weight
NBC	Nuclear, Biological, and Chemical
NBCRS	Nuclear, Biological, and Chemical Reconnaissance System
OSAGWI	Office of the Special Assistant for Gulf War Illness
PLL	Prescribed Load List
PMCS	Preventative Maintenance Checks and Services
TRADOC	Training and Doctrine Command
US	United States
USAEUR	United States Army Europe
VOS	Vehicle Orientation System

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## TAB C - FOX CHEMICAL LIBRARY AND PARAMETER SETTINGS

The following table shows the interference and reliability parameter for every chemical in the Fox Chemical Library. The Impossible Ion parameter setting depends on what likely interferent is present in the area the Fox is operating and thus varies for every interfering agent.

Chemical	Interference Parameter	Reliability Parameter	Impossible Ion by Molecular Weight
TABUN	8.0	3.0	
SARIN	8.0	3.0	
CHLORSARIN	8.0	3.0	
SOMAN	8.0	3.0	
CHLORSOMAN	8.0	3.0	
DFP	8.0	3.0	
VX	8.0	3.0	
S-MUSTARD	8.0	3.0	
HT-MUSTARD	8.0	3.0	
HQ-MUSTARD	8.0	3.0	
N-MUSTARD	8.0	3.0	
LEWISITE	8.0	3.0	
PHOSGENOX	8.0	4.0	
PFIB	4.0	4.0	
PHOSGENE	2.0	3.0	109 m.w.
THIOPHOSGENE	2.0	3.0	
CHLORPICR	3.0	2.0	
ME-DICK	2.0	3.0	
ET-DICK	2.0	3.0	
PH-DICK	2.0	3.0	
ADAMSITE	2.0	3.0	
HCN	1.0	2.0	57 m.w.
CHLORCYAN	1.0	1.5	145 m.w.
BROMCYAN	1.0	2.5	
BZ	2.0	3.0	
CS	1.0	3.5	
CN	1.0	3.0	
CR	1.0	3.0	
CLARK I	1.0	3.5	
CLARK II	1.0	3.5	
BR-ACETONE	1.0	3.0	
CYCLOSARIN	8.0	3.5	97 m.w.
BR-AC-ME-ESTER	1.0	3.0	
BENZYL BROMIDE	1.0	3.5	

Chemical	Interference Parameter	Reliability Parameter	Impossible Ion by Molecular Weight
XYLYBROMIDE	1.0	2.5	
BROMBENZYL CYAN	1.0	3.5	
1,4-DITHIAN	1.0	3.5	
S-LOST SULFONE	2.0	4.0	
VX_THIOL	8.0	3.0	
PRECURSOR GA	2.0	3.0	
PRECURSOR GB	2.0	3.0	
BINARY GB	2.0	3.5	
BINARY VX	2.0	3.5	
THIONYL-CL	2.0	4.0	
PHOSPHORYL-CL	1.0	2.5	
THIODIGLYCOL	2.0	3.5	
S-DICHLORIDE	2.0	3.5	
PCL3	2.0	2.5	
ASCL3	2.0	2.0	
DIME-PHOSPHITE	1.0	3.5	
DIET-PHOSPHITE	1.0	3.0	
TRIME-PHOSPHIT	1.0	3.0	
TRIET-PHOSPHIT	1.0	3.0	
TNT	1.5	3.0	
CL4-ETHENE	1.0	2.5	
CL1-BENZENE	1.0	2.5	
DIME-PHTHATLATE	1.0	3.0	
DIET-PHTHATALATE	1.0	3.0	
FC 77	0.5	1.5	
FAT,OIL,WAX	0.6	6.0	

# Case Narrative

## Fox Detections in an ASP/Orchard

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on reports of possible chemical agent detections by a Fox vehicle attached to Task Force Ripper in an Ammunition Supply Point (ASP) in an Orchard southwest of Kuwait City. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding these possible chemical agent detections. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997265-0000-015

Last Update: September 23, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DOD) established a task force in June 1995 to investigate all possible causes. On November 12, 1996, responsibility for these investigations was assumed by the Investigation and Analysis Directorate (IAD), Office of the Special Assistant for Gulf War Illnesses (OSAGWI), which has continued to investigate reports of chemical agent detections by U.S. Marines during the ground war.

As part of the effort to inform the public about the progress of this effort, DOD is publishing on the Internet and elsewhere accounts related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling the account. The narrative that follows is such an account.

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## METHODOLOGY

During and after the Gulf War, people reported that they had been exposed to chemical warfare agents. To investigate these incidents and to determine if chemical weapons were used, the DOD developed a methodology for investigation and validation based on work done by the United Nations and the international community where the criteria include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation or human/animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by experts.

While the DOD methodology (Tab D) for investigating chemical incidents is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, our methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

By following our methodology and accumulating anecdotal, documentary, and physical evidence, and by interviewing eyewitnesses and key personnel, and analyzing the results, the investigator can assess the validity of the presence of chemical warfare agents on the battlefield. Because information from various sources may be contradictory, we have developed an assessment scale (Figure 1) ranging from "Definitely" to "Definitely Not" with intermediate assessments of "Likely," "Unlikely," and "Indeterminate." This assessment is tentative, based on facts available as of the date of the report publication; each case is reassessed over time based on new information and feedback.

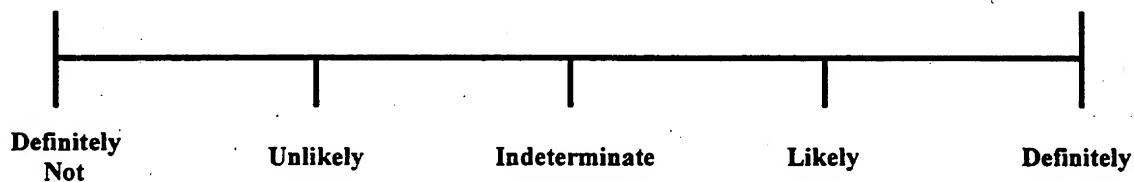


Figure 1. Assessment of Chemical Warfare Agent Presence

The standard for making the assessment is based on common sense: do the available facts lead a reasonable person to conclude that chemical warfare agents were or were not present? When insufficient information is available, the assessment is "Indeterminate" until more evidence can be found.



## SUMMARY

On 28 February, 1991, a Fox vehicle belonging to Task Force Ripper was directed to inspect an Ammunition Supply Point (ASP) located southwest of Kuwait International Airport, in the vicinity of map coordinates QT75393910. While inspecting the ASP, the Fox crew reported alerting on traces of three different chemical agents within 100 meters of each other. The Fox vehicle MM-1 Mass Spectrometer operator printed tapes of the three alarms. The vehicle commander, GySgt Grass, passed these tapes to his chain-of-command, which, in turn, reported up through the 1<sup>st</sup> MarDiv to Central Command (CENTCOM). As a result, an Explosive Ordnance Disposal (EOD) team was sent to the ASP the following day. After a thorough inspection on March 1, 1991, the EOD team did not find any chemical weapons. The negative results of this inspection were also passed up the 1<sup>st</sup> MarDiv chain-of-command, and reported in the CENTCOM Logs. The ASP was dismantled during cleanup operations in Kuwait after the Gulf War. No chemical weapons were found during these cleanup operations.

Based on extensive research of all available documentation on these events, numerous interviews of the personnel involved, as well as the United Nations' Special Commission on Iraq (UNSCOM) and the Intelligence Community's assessment that Iraq never moved chemical agents or weapons into Kuwait, we assess it is unlikely there were chemical weapons stored in this ASP. These alerts were most probably false positives caused by battlefield contaminants, contaminants from the orchard and/or contaminants from a nearby industrial facility.

## NARRATIVE<sup>1</sup>

### Background

In May 1996 and May 1997, Gunnery Sergeant (GySgt) George Grass, testified before the Presidential Advisory Committee on Gulf War Veterans' Illnesses about several suspected chemical weapons incidents of which he had personal knowledge during the Gulf War. GySgt Grass was a Marine Corps Nuclear, Biological and Chemical (NBC) weapons defense specialist and Fox Vehicle Commander. He also testified in December 1996 before the Government Reform and Oversight Subcommittee of the House of Representatives. In each testimony, GySgt Grass discussed several specific Fox alerts for chemical warfare agents (CWA), including three at an Ammunition Supply Point located southwest of Kuwait City. The first public discussion of this event occurred in 1993, when a Marine linked his service with Marine units during the Gulf War to a severe disease he was suffering. He asked several Marine NBC specialists, including GySgt Grass to make statements about any CWA they may have detected during the war. Several Marines were then asked to testify in front of several congressional committees in 1993 and 1994—which they did. In 1994, the Marine Corps initiated an investigation in response that concluded the Marine was not suffering from any classical chemical warfare exposures.<sup>2</sup>

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<sup>1</sup> An acronym listing/glossary is at Tab A.

<sup>2</sup> *Investigation to Inquire into the Circumstances surrounding the Possible Exposure of Sergeant [Name Deleted] USMC to Chemical Agents During Operation Desert Storm*. Finding 36, 1<sup>st</sup> MEF, USMC, 22 Feb 1994.

## Task Force Ripper Chain-of-Command

The ground war to liberate Kuwait began on February 24, 1991. By February 28th, after four days of fighting and movement, the 7<sup>th</sup> Marine Regiment, known as Task Force Ripper, was headquartered at Al Jaber Airfield and the 1<sup>st</sup> Marine Division (1<sup>st</sup> MarDiv) had taken their objectives around Kuwait City. Task Force Ripper was part of the 1<sup>st</sup> MarDiv—which was in turn a major subordinate unit of the I Marine Expeditionary Force (I MEF). (Figure 2) Most of the units discussed in this narrative were in the 1<sup>st</sup> MarDiv or under this division's operational control. Task Force Ripper consisted of the three battalions of the 7<sup>th</sup> Marine Regiment: the 3<sup>rd</sup> Tank Battalion, the 1st Battalion of the 5<sup>th</sup> Marine Regiment (1/5), and the 1st Battalion of the 7<sup>th</sup> Marine Regiment (1/7). Task Force Ripper was also augmented with forces from the 1<sup>st</sup> Combat Engineer Battalion, the 3<sup>rd</sup> Amphibious Assault Battalion and the 3<sup>rd</sup> Battalion of the 11<sup>th</sup> Marine Regiment (3/11), which provided artillery support. The 1<sup>st</sup> MarDiv also gave Task Force Ripper one of the four Fox NBC Detection vehicles attached to the division.<sup>3</sup> (Figure 3) The Task Force Ripper Fox vehicle was commanded by GySgt Grass.

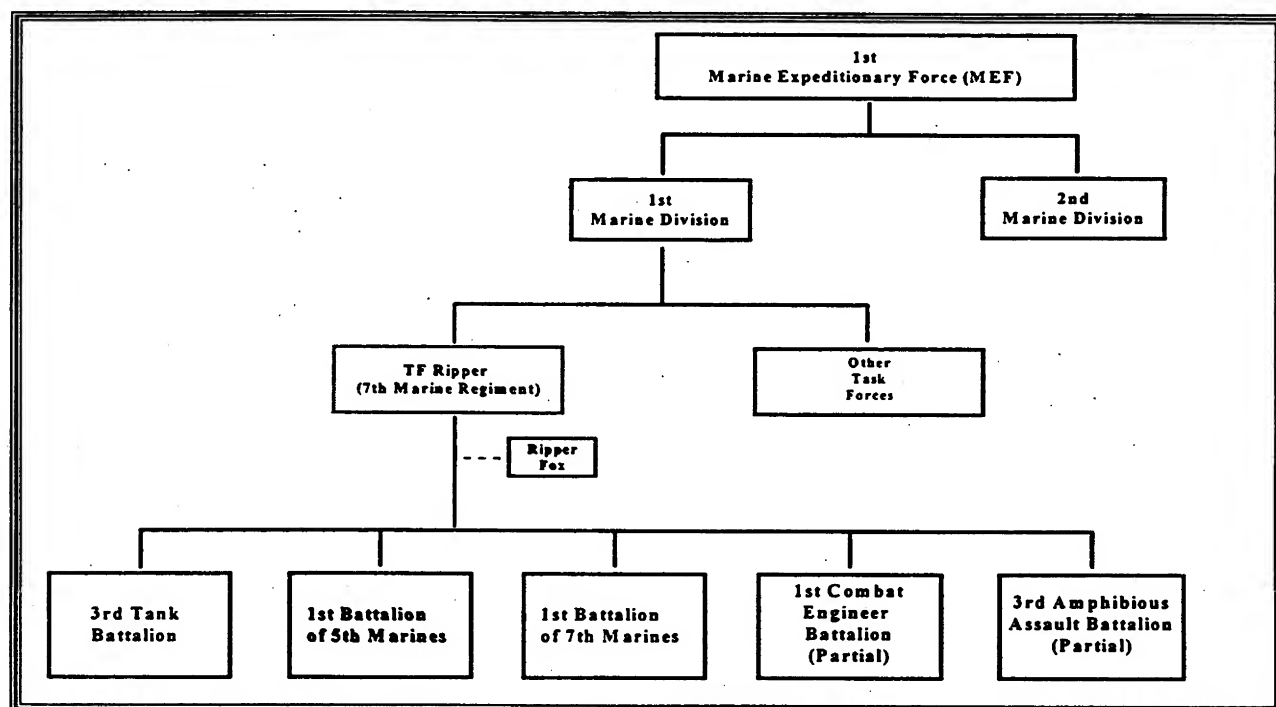


Figure 2. Organizational Chart

<sup>3</sup> Interview with Task Force Ripper NBC Officer, Lead sheet 5325.



Figure 3. A Fox NBC Reconnaissance Vehicle in Desert Storm Camouflage.

### Description of the ASP

The ASP GySgt Grass was sent to inspect was located outside the ring road around Kuwait City in an orchard or tree farm, southwest of Kuwait International Airport. (Figures 4 and 5)

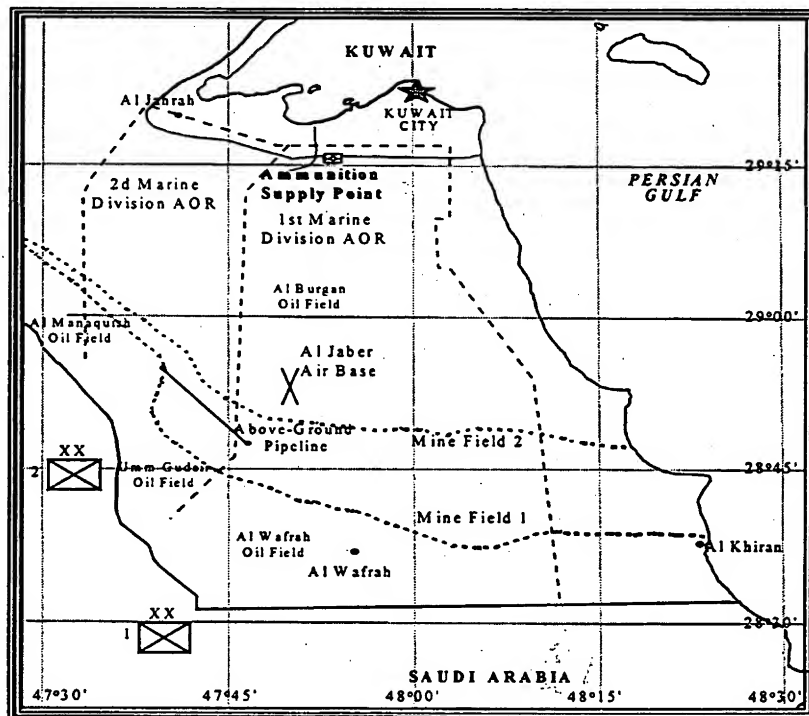


Figure 4. Location of ASP

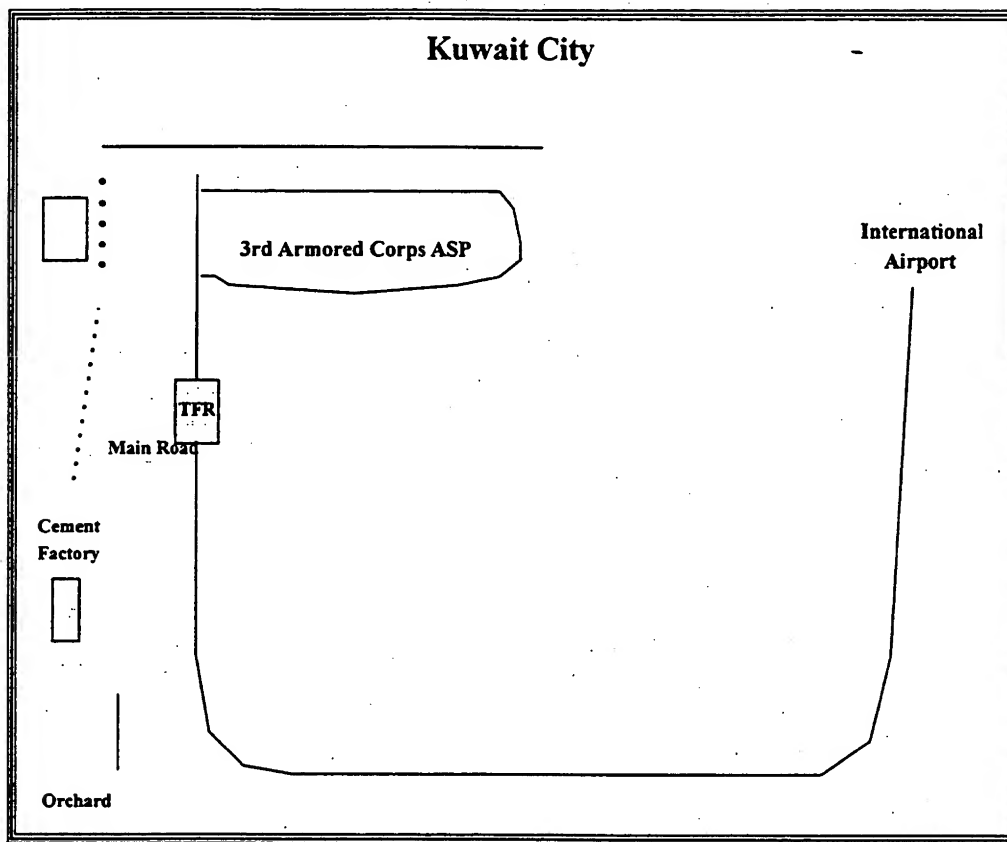


Figure 5. Location of ASP<sup>4</sup>

Several reports of an industrial area across the road were gathered from interviews.<sup>5</sup> Elements of the 1<sup>st</sup> Battalion of the 5<sup>th</sup> Marines (1/5) were camped around the area. GySgt Grass's journal entry placed the ASP at map grid coordinates QT 766395,<sup>6</sup> but message traffic and log entries from February 28<sup>th</sup> placed it at QT 75393910. The driver of Grass's Fox vehicle believes the disparity between the two map grid coordinates is the result of inherent inaccuracies in the Vehicle Orientation System used by the Fox vehicle during the Gulf War.<sup>7</sup>

The munitions stored in the ASP included small arms ammunition and artillery rounds. Visual inspections conducted by the Explosive Ordnance Disposal (EOD) personnel and Marines from the 1/5 determined the munitions were primarily manufactured in the Soviet Union and the Warsaw Pact. The writing on the sides of the ammunition boxes indicated some of these

<sup>4</sup> Drawing provided by GySgt George Grass. TFR stands for Task Force Ripper.

<sup>5</sup> Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines NBC Officer, Lead Sheet 5370, dated July 1, 1997 and Interview with Fox #5604 Driver, Lead Sheets 5353 and 5359, dated December 7, 1993, May 31, 1996 and June 27, 1997.

<sup>6</sup> GySgt George Grass' Gulf War Journal.

<sup>7</sup> The Vehicle Orientation System (VOS) relied on number of wheel revolutions to determine its relative position. Therefore, anytime the wheels turned without moving the vehicle (for example, when stuck in the sand) the location displayed by the VOS would be inaccurate from that point on. Resetting the VOS required a major land feature to be in the line of sight - an infrequent occurrence in the desert. The VOS has since been replaced with the more accurate Global Positioning Satellite (GPS) system.

munitions may have entered Iraq through Jordan.<sup>8</sup> There are also conflicting reports of munitions manufactured in Holland and the United States.<sup>9</sup> Despite these reports, members of the EOD team have stated: "There is NO CHANCE that we missed U.S. ordnance or forgot seeing it. As for Dutch ordnance, that also would be very hard to forget seeing, as it would be quite a rare find."<sup>10</sup>(*emphasis in original*)

According to GySgt Grass, the ASP was divided into two sections: a larger area with hundreds of bunkers and a smaller area located across the road. The chemical agent alarms occurred in the smaller area. This area was bermed all around and there was a line of trees impeding the view of the main road. A small brick building and a dug-in Winnebago, or motor home, stood at the entrance of this smaller area. A road circled the inside of the smaller ASP and there were roads between each row of bunkers. (Figure 6) This smaller area was also configured differently than the larger ASP. GySgt Grass describes it this way in his testimony:

Completing the Army Technical Escort course seven months prior to deployment to SWA [Southwest Asia], being a former Ammunition Technician for 6 years and working as the NCOIC [Non-Commissioned Officer in Charge] of the Marine Corps Offensive Chemical Weapons unit, I observed several signs of possible chemical weapons storage. There were fire extinguishers colored in red, blue or green with each grouped in a specific area according to their color....Also this particular storage area had several ... open top 55 gallon drums that were painted all blue, red and blue, olive drab green and white and green. Each set of drums were grouped together according to its color and whether the color of the drum was solid or striped. No other area ... that my Fox vehicle checked was designed and set up like that area.<sup>11</sup>

GySgt Grass's journal entry from the time ("What do blue, red & green fire exting[uishers] mean?"<sup>12</sup>) indicates he was unsure of the meaning of this configuration while in the ASP. However, the leader of the EOD team inspecting the ASP the following day (who was also trained to look for visual cues indicating chemical weapons storage), does not recall concluding that the area was arranged in a manner indicating chemical weapons' storage. He remembers the open 55-gallon drums and recalls that they were full of water—"standard for an ASP"—for fire fighting purposes. The EOD team leader also recalls the different colored fire extinguishers, but he does not consider them as evidence of a chemical weapons storage area.

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<sup>8</sup> Testimony of GySgt George Grass, 1 May 96; Interview with member of EOD team, CMAT Number 1997170-0000026 and Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively.

<sup>9</sup> Testimony of GySgt George Grass, 1 May 96 and Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively.

<sup>10</sup> Letter to Representative Shay, Chairman of the House Government Relations and Oversight Subcommittee from member of EOD team, December 19, 1996, CMAT Number 1997169-0000-054.

<sup>11</sup> Testimony of GySgt George Grass, 10 Dec 96.

<sup>12</sup> GySgt George Grass' Gulf War Journal.

After the war local merchants told stories of Iraqis using their 'AK-47 Express Card' to retrieve whatever the military needed. When stocking their field ASPs, the Iraqis took whatever fire extinguishers were available without regard to color.<sup>13</sup>

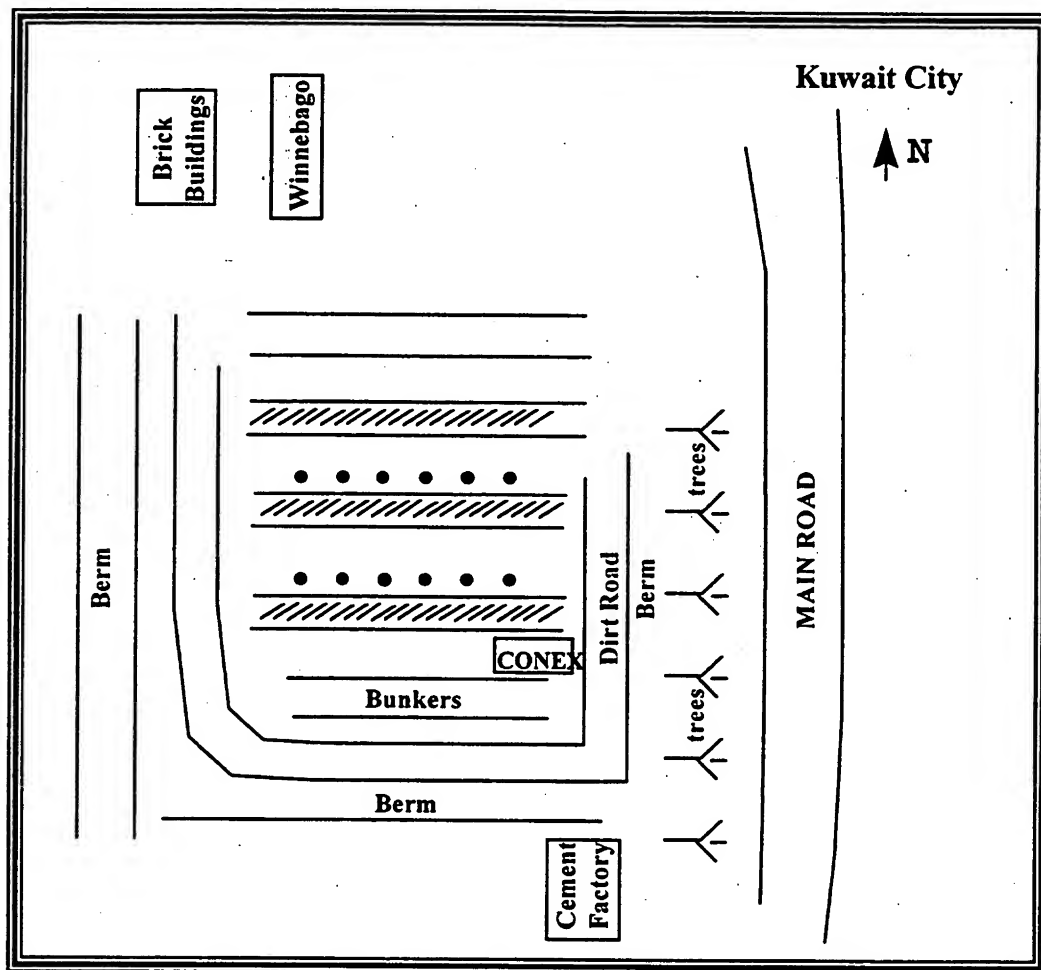


Figure 6. Diagram of Small ASP<sup>14</sup>

### Why Chemical Weapons Were Suspected

According to GySgt Grass, reports from Iraqi Prisoners of War indicated the possible presence of chemical weapons in the ASP.

During the intelligence briefing that morning, it was stated by the S-2 [Task Force Ripper's Intelligence Officer] that the Iraqi's had established the 3d Armored Corps Ammunition Supply Point just outside of Kuwait City and that sources

<sup>13</sup> Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively.

<sup>14</sup> Provided by GySgt George Grass.

(Iraqi prisoners) have stated there were chemical weapons stored somewhere within the Ammo Storage Area. I was informed that my task was to do a complete survey of the entire ASP and locate any chemical weapons that may be stored there.<sup>15</sup>

Task Force Ripper's NBC Officer remembers, "[we] wouldn't have been surprised to find chemical weapons in there."<sup>16</sup> It was Standard Operating Procedure to assume the possibility of chemical weapons in any Iraqi ASPs.<sup>17</sup>

### Fox Vehicle Capabilities

The primary chemical agent detector on the Fox vehicle is the MM-1 mass spectrometer. The MM-1 detects chemical agents by analyzing the ionic activity of a sample collected through a retractable probe. The probe can collect samples by "sniffing" the surrounding air (the "Air/Hi" method) or by taking them from a silicone wheel which is lifted from the ground to the probe (the "Surface/Lo" method). At the time it entered the ASP on February 28<sup>th</sup>, 1991, the Fox MM-1 probe was sniffing the air in the "Air/Hi" method. This is the least sensitive of the Fox methods of chemical detection and more than 100 times less sensitive than an M256 kit. (Table 1) In the "Air/Hi" method, the MM-1 is performing a "quick-look" analysis of air samples, looking for ions that resemble chemical agents.

Item	Agents - Type	Sensitivity	Response Time
M8A1 Alarm	G, V - Nerve	0.1-0.2 mg/m <sup>3</sup>	<=2 min
M256A1 Kit	G - Nerve	0.005 mg/m <sup>3</sup>	15 min
	V - Nerve	0.02 mg/m <sup>3</sup>	15 min
	H - Blister	2 mg/m <sup>3</sup>	15 min
	L - Blister	9 mg/m <sup>3</sup>	15 min
	CX - Blister	3 mg/m <sup>3</sup>	15 min
	CK - Blood	8 mg/m <sup>3</sup>	15 min
	AC - Blood	9 mg/m <sup>3</sup>	25 min
CAM	GA, GB, VX, HD, HN	<= 0.1 mg/m <sup>3</sup>	<=1 min
MM-1 <sup>18</sup>	GB <sup>19</sup> - Nerve	62 mg/m <sup>3</sup>	<=45 sec
	CK - Blood	46 mg/m <sup>3</sup>	
	CG - Choking	115 mg/m <sup>3</sup>	

Table 1. Vapor Chemical Agent Detector Characteristics<sup>20</sup>

<sup>15</sup> Testimony of GySgt George Grass, 10 Dec 96.

<sup>16</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325, dated June 18, 1997.

<sup>17</sup> Interview with 1<sup>st</sup> MarDiv NBC Officer, Lead Sheet 5263, dated June 13, 1997.

<sup>18</sup> Because the minimum detectable amount is calculated from the background and backgrounds vary—dependent on environmental and atmospheric conditions—the minimum detectable amounts will vary. The sensitivities listed in Table 2 are relevant only for the specific conditions they were calculated from.

<sup>19</sup> At this level unprotected personnel would experience moderate to severe symptoms from Sarin before the MM-1 would alert.

<sup>20</sup> Report of the Defense Science Board Task Force on Persian Gulf War Health Effects; June 1994 Table 18, Gulflink, <http://www.gulflink.osd.mil/dsbrpt/table18.gif>.

If the MM-1 alerts to a possible chemical agent, there is an audible alarm. A full spectrum analysis must then be performed to confirm or deny the presence of chemical agents. The preferred method for performing a full spectrum is the "Surface/Lo" method: the MM-1 probe is extended to the ground (usually to a suspected liquid chemical agent) and the operating temperature of the MM-1 is lowered. Only by performing a full spectrum can an alert be confirmed or denied solely by the Fox vehicle. A "tape," which provides details of the MM-1's findings, can be printed as a permanent record of the initial alert and the full spectrum.

During the Gulf War, the Fox vehicle was manned by a crew of four—the Fox vehicle commander, a driver, an MM-1 operator and a wheel operator. The wheel operator uses levers inside the vehicle to lift the silicone wheels from the ground to the probe for sampling. The driver and commander sit in the front of the vehicle, while the MM-1 and wheel operators sit in the rear. The two areas are connected by a narrow crawl-through.<sup>21</sup>

### Alerts in the ASP on February 28<sup>th</sup>

According to GySgt Grass' testimony, the first alarm in the ASP occurred "while [the Fox was] monitoring for chemical agent vapors."<sup>22</sup> The MM-1 alarm "was set off with a full distinct spectrum across the monitor and a lethal vapor concentration of S Mustard."<sup>23</sup> In his testimony, the MM-1 operator stated the Fox crew was outside the vehicle trying to get a closer look at some bunkers when they heard the alarm.<sup>24</sup> He does not mention what Mission Oriented Protective Posture<sup>25</sup> (MOPP) level the crew was in, but both the driver and the wheel operator recall never being higher than MOPP-2—that is, carrying, but not wearing, their protective masks and gloves—while outside the Fox in this ASP.<sup>26</sup> None of the exposed crew experienced any symptoms consistent with exposure to chemical agents while in the ASP.

When the MM-1 sounded the alarm, the crew returned to the vehicle and drove closer to the nearest dug-in bunker. In subsequent testimony and interviews, GySgt Grass recalls the following: "...[F]ully visible were the skull and cross bones either on yellow tape with red lettering or stenciled to the boxes or some had a small sign with the skull and crossbones painted

<sup>21</sup> For more information on the Fox vehicle, please refer to the Fox NBC Reconnaissance Vehicle Information Paper - HTML Link to Fox Paper.

<sup>22</sup> Testimony of GySgt George Grass, 11 Jan 94. This same information about the Fox Vehicle alerts in the ASP is also reported in the Department of Defense Intelligence Oversight Committee Report: *Iraqi Chemical Warfare: Analysis of Information Available to DOD (U)*, Section 11 (U) *Possible CW Agent Release*, June 16, 1997, p. 19-20. HTML Link to Mitre Report. However, as noted in the discussion on pages 16 and 17 of this narrative, recollections of the results of the inspection differ. Based on Grass's testimony, the Mitre report says the EOD team confirmed the presence of chemical weapons; but numerous interviews with the EOD team indicated their inspections turned up no evidence of chemical weapons in the ASP, which was reported up the chain of command. In addition to these interviews these results were confirmed in a letter sent to Congressman Shay by a member of the EOD team. HTML Link to Letter to Representative Shay, Chairman of the House Government Relations and Oversight Subcommittee from member of EOD team, December 19, 1996, CMAT Number 1997169-0000-054.

<sup>23</sup> Testimony of GySgt George Grass, 14 Mar 96.

<sup>24</sup> Testimony of Fox #5604 MM1 Operator, Lead Sheet 5183, dated June 4, 1997.

<sup>25</sup> For more on MOPP see the MOPP Information Paper - HTML Link

<sup>26</sup> Interview with Fox #5604 Wheel Operator, Lead Sheet 5411, dated July 2, 1997 and Interview with Fox #5604 Driver, Lead Sheets 5353 and 5359, dated December 7, 1993, May 31, 1996 and June 27, 1997.



on it.”<sup>27</sup> Several “155mm rounds with colored bands around them”<sup>28</sup> were stacked on top of some boxes in the bunker. “The labeling on the boxes was from the United States.”<sup>29</sup> GySgt Grass identified these rounds as the source of the Sulfur Mustard alarm. He also stated they were not leaking.<sup>30</sup>

Once the Fox backed up to the bunker, a “full and complete spectrum was taken and printed out as proof of the detection.”<sup>31</sup> GySgt Grass does not know the exact procedures the MM-1 operator used, but stated, “I know we didn’t check for liquid contamination – everything was all vapor.”<sup>32</sup> A complete spectrum, detailing the exact ionic makeup of the surrounding area, is the only way to affirm an initial alert is a “confirmed detection.” During his testimony, the MM-1 operator did not discuss the procedures he used to obtain a spectrum while in the ASP. We have attempted to interview the MM-1 operator to obtain additional information, but have so far been unsuccessful. The wheel operator (the other member of the crew located in the back of the Fox with the MM-1 operator) was interviewed but could not recall the procedures used to get the spectrum. It is possible to print a tape of an initial alarm without conducting a complete, confirming spectrum. A tape printed from an initial alarm will have the name of the suspected agent in capital letters across the top. Without clarification from the MM-1 operator and a copy of the tape printed, we cannot determine the exact ion make up of the alert.

After the MM-1 operator printed the tape, GySgt Grass notified the Task Force Ripper NBC Officer that they had found some “Honey.” (To avoid alarming the entire Task Force, the Task Force Ripper NBC Officer told the Fox crew to use the code word “Honey” if they had any chemical alerts while in the ASP.)<sup>33</sup> The Task Force Ripper NBC Officer ordered the crew to “return to [Task Force] Ripper’s Main [Headquarters location].”<sup>34</sup>

The MM-1 operator testified that the three alarms at the smaller ASP occurred at the same time, with each of the three agents alerting the MM-1 simultaneously. “There were a number of readings on the MM-1’s computer screen. They were S mustard, HT mustard and a benzene [*sic*] bromide agent....[A] couple of spectrums were run and the printouts were given to [GySgt] Grass.”<sup>35</sup> GySgt Grass, however reports the three alarms as separate events. He describes the second alarm this way:

[a]s we continued driving through the ammo storage area the alarm sounded again. The chemical agent HT Mustard in a lethal dose came across the monitor. Again, the skull and crossbones were present although the boxes were closed with

<sup>27</sup> Testimony of GySgt George Grass, 14 Mar 96.

<sup>28</sup> Testimony of GySgt George Grass, 10 Dec 96.

<sup>29</sup> Testimony of GySgt George Grass, 10 Dec 96.

<sup>30</sup> Interview with GySgt George Grass, 20 February 1997, p. 68.

<sup>31</sup> Testimony of GySgt George Grass, 10 Dec 96.

<sup>32</sup> Interview with GySgt George Grass, 20 February 1997, p. 61.

<sup>33</sup> Interview with GySgt George Grass, 20 February 1997, p. 62.

<sup>34</sup> Testimony of GySgt George Grass, 10 Dec 96.

<sup>35</sup> Testimony of Fox #5604 MM1 Operator, Lead Sheet 5183, dated June 4, 1997.

markings from the United States and Holland. A full spectrum on the Mass Spectrometer was easily accomplished and printed out as proof of detection.<sup>36</sup>

GySgt Grass does not identify a specific type of ammunition as the source for this alarm. As with the alarm for Sulfur Mustard, we have no information on the procedures the MM-1 operator used to obtain a spectrum and print the tape for HT Mustard. After printing the tape, the Fox crew continued on its way out of the ASP.

According to GySgt Grass, the third and final alarm in the ASP occurred as the crew was driving out of the area.

[T]he alarm sounded once more showing a positive reading of Benzene [sic] Bromide. This reading was taken next to a large metal container with no distinct markings. The vapor concentration was in the air and a full spectrum was ran [sic] on the Mass Spectrometer and printed out as proof of the detection.<sup>37</sup>

During an interview, GySgt Grass identified a large shipping container, or Conex box, located in the southeast corner of the ASP as the possible source of this alarm.<sup>38</sup> (Figure 6) Although GySgt Grass stated the Fox was only checking for vapor concentration while in the ASP<sup>39</sup> (indicating the "Air/Hi" method was being used), it is unclear what method the Fox vehicle was using when the MM-1 got this alarm. Benzyl Bromide, a tearing agent, is one of the 60 chemicals for which the MM-1 monitors, but it is not normally one of the 10 or 11 chemicals typically monitored for while using the "Air/Hi" method. As with the two other alarms, we have no information on the procedures the MM-1 operator used to obtain a spectrum and print the tape.

After printing this third tape, the Fox crew drove past several other bunkers in the area without incident prior to departing the ASP. They then drove to the headquarters area of the 1<sup>st</sup> Battalion of the 5<sup>th</sup> Marines (1/5), located nearby, to warn the 1/5 NBC Officer of the possibility of chemical agents or weapons in the ASP. After stopping at the 1/5, the Fox crew returned to Task Force Ripper's Headquarters.

### 1/5 Marines Actions

The 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines took control of the ASP without resistance during the night of the third or fourth day of the ground war. By the time of the cease-fire on February 28th, they had established a defensive position at the ASP. The Commanding Officer and the Executive Officer of the 1/5 do not recall hearing of chemical alerts or the possible presence of chemical weapons

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<sup>36</sup> Testimony of GySgt George Grass, 10 Dec 96.

<sup>37</sup> Testimony of GySgt George Grass, 10 Dec 96.

<sup>38</sup> Interview with GySgt George Grass, 20 February 1997, p. 60. Grass described the Conex box as being like "the back of a tractor-trailer that's been set down on the ground and painted green."

<sup>39</sup> Interview with GySgt George Grass, 20 February 1997, p. 61.

in the ASP.<sup>40</sup> The 1/5 NBC Officer recalls the presence of the Fox vehicle, but is not sure what day it was there. He remembers the vehicle alarming for a chemical, but does not recollect the specific agent. The 1/5 NBC Officer recalls that, after alarming, the Fox drove around the area attempting to recreate the alarm, but was unsuccessful. The NBC Officer also reports that at some point while the 1/5 was encamped nearby, he led a team through the ASP with Chemical Agent Monitors (CAMs) and determined the ASP was only stocked with conventional munitions. There are conflicting memories as to whether the NBC Officer led his team through the ASP while the Fox crew was there or at some other time. The 1/5 NBC Officer reported the Fox alarm up his chain of command to the 1/5 Assistant Operations Officer.<sup>41</sup> The Assistant Operations Officer recalls being told a Fox vehicle drove through the ASP and detected Mustard but then lost its detection<sup>42</sup>—and so was unable to confirm the alarm. As the Fox was unable to recreate its initial alert and the CAM tests proved negative, the 1/5 NBC Officer and the Assistant Operations Officer decided there was no need to move their unit to a new location.<sup>43</sup> The ASP was not cordoned off or declared off limits.<sup>44</sup>

### Task Force Ripper Actions

After stopping at the 1/5 Headquarters area, the Fox crew returned to Task Force Ripper's Headquarters area. Upon arriving, GySgt Grass recalls going to the command post tent to report the agents his vehicle had alarmed for in the ASP. GySgt Grass passed the MM-1 tapes printed in the ASP to the Task Force Ripper NBC Officer and explained what he thought he'd found there to members of the Task Force Ripper command staff.<sup>45</sup> At this meeting, it was decided that the 1<sup>st</sup> MarDiv headquarters, code-named PRIDE<sup>46</sup>, should be notified.<sup>47</sup> At 1531 hours on February 28<sup>th</sup>, the following message was passed from Task Force Ripper to PRIDE:

1. Have detected S mustard, HT mustard and Benzine [sic] Bromide at grid QT75393910.
2. Means of detection: Fox vehicle.
3. Hazard seems to be very localized vapor from bunker complex.<sup>48</sup>

At 1720 hours the same day, the 1<sup>st</sup> MarDiv radioed Direct Support Command (DSC) requesting Explosive Ordnance Disposal (EOD) support for the next day, March 1<sup>st</sup>.

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<sup>40</sup> Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Executive Officer, Lead Sheet 5338, dated June 25, 1997 and Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Commanding Officer, Lead Sheet 5333, dated June 24, 1997.

<sup>41</sup> Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines NBC Officer, Lead Sheet 5370, dated July 1, 1997.

<sup>42</sup> Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Assistant Operations Officer, Lead Sheet 5352, dated June 26, 1997.

<sup>43</sup> Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines NBC Officer, Lead Sheet 5370, dated July 1, 1997.

<sup>44</sup> Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Assistant Operations Officer, Lead Sheet 5352, dated June 26, 1997; Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Commanding Officer, Lead Sheet 5333, dated June 24, 1997 and Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Executive Officer, Lead Sheet 5338, dated June 25, 1997.

<sup>45</sup> Testimony of GySgt George Grass, 14 Mar 96.

<sup>46</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325, dated June 18, 1997.

<sup>47</sup> Testimony of GySgt George Grass, 14 Mar 96.

<sup>48</sup> 1<sup>st</sup> MarDiv Radio Message Traffic from Ripper to PRIDE, Gulflink  
[http://www.dtic.mil/gulflink/db/marines/123096\\_oct96\\_decls10\\_0001.html](http://www.dtic.mil/gulflink/db/marines/123096_oct96_decls10_0001.html).

Req EOD support at QT 75393910 suspected chemical mustard agent munitions in Ammo bunker agent detected by Fox vehicle.  
POC TF [Task Force] RIPPER NBCO at grid QT 805350.<sup>49</sup>

GySgt Grass was told to escort the EOD team back to the ASP the next day.

### Units and Logs Recording Alerts

During the evening of February 28<sup>th</sup>, the Task Force Ripper Fox alerts were recorded in several unit logs throughout the 1<sup>st</sup> MarDiv, including the 5<sup>th</sup> Battalion of the 11<sup>th</sup> Marines (5/11):

Fm Div  
To All units  
Possible Mustard Hazard  
QT 7539/3910  
Vapor Hazard local to area.  
Hazard appears to be from bunker in that area  
Method of detection left by Fox veh[icle]<sup>50</sup>

The 1<sup>st</sup> Reconnaissance Battalion of the 1<sup>st</sup> MarDiv also logged the alerts:

1620 281620C Feb 1991 Possible mustard agent QT 75393910 localized to area appears to be from bunkers. Fox vehicle detected.<sup>51</sup>

The 1<sup>st</sup> Battalion of the 12<sup>th</sup> Marines (1/12), which was assigned to 11<sup>th</sup> Marines, also reported "Mustard agent hazard in bunker" on the 28<sup>th</sup>.<sup>52</sup>

Central Command (CENTCOM) received a SPOT Report (SPOTREP) from the 1<sup>st</sup> MarDiv at 2150 local time on the 28<sup>th</sup>:

1<sup>st</sup> MarDiv rpts.  
Probable ammo bunker w/ chemical munitions, vic[inity] of 2914N/4750E, 5 miles west of Ku[wait] City airport.  
Area has been cordoned off.  
EOD personnel will enter bunker tomorrow morning.<sup>53</sup>

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<sup>49</sup> 1<sup>st</sup> MarDiv Radio Message Traffic from Division to DSC, Gulflink [http://www.dtic.mil/gulflink/db/marines/123096\\_oct96\\_decls11\\_0001.html](http://www.dtic.mil/gulflink/db/marines/123096_oct96_decls11_0001.html).

<sup>50</sup> Command Chronology 5<sup>th</sup> Battalion 11<sup>th</sup> Marines Journal Files, Daily Journal 28Feb91, Gulflink [http://www.dtic.mil/gulflink/db/marines/121096\\_sep96\\_decls24\\_0003.html](http://www.dtic.mil/gulflink/db/marines/121096_sep96_decls24_0003.html).

<sup>51</sup> Command Chronology 1<sup>st</sup> Reconnaissance Battalion Jan - Mar 1991, Journal 1<sup>st</sup> Recon BN 28 Feb 91, Gulflink [http://www.dtic.mil/gulflink/db/marines/121096\\_sep96\\_decls20\\_0004.html](http://www.dtic.mil/gulflink/db/marines/121096_sep96_decls20_0004.html).

<sup>52</sup> Command Chronology 1<sup>st</sup> Battalion 12<sup>th</sup> Marine Regiment Mar - Jun 1991, Incidents Messages Orders Journal, Gulflink [http://www.dtic.mil:80/gulflink/db/marines/102596\\_sep96\\_decls22\\_0001.html](http://www.dtic.mil:80/gulflink/db/marines/102596_sep96_decls22_0001.html).

The CENTCOM logs then recorded the following:

281930 [1<sup>st</sup> MEF NBC Watch Officer] called. 1<sup>st</sup> MarDiv has come across an ammo bunker complex (QT75393910) with suspected chemical munitions. The Fox (GCMS) [sic] has come up with indications of small conc [sic] of sulfur mustard after numerous tests. All possible interferences with petroleum products ruled out. They are outside the bunker now, no one has gone in. They've moved their EOD people up, but won't do anything until the morning. Area is cordoned off, all their people in the area have been warned.<sup>54</sup>

### **EOD Team Inspection on March 1, 1991**

The next day, March 1<sup>st</sup>, GySgt Grass and his Fox crew escorted a five member EOD team to the ASP. This team was part of the 1<sup>st</sup> Force Service Support Group (FSSG) EOD Platoon, 7<sup>th</sup> Engineer Support Battalion, which was working at Al Jaber Airfield. We have interviewed the four members of this team who entered the ASP, as well as the Officer in Charge (OIC) of the 1<sup>st</sup> FSSG EOD Platoon during the Gulf War, to whom the EOD team reported their findings. We are in the process of contacting the fifth member of the EOD team, a communications specialist who did not enter the ASP.

When they arrived at the ASP, the EOD team established a command post in their vehicle (a HMMWV or "Humvee") and donned their protective gear—a standard precaution for any suspected contaminated area.<sup>55</sup> The team then conducted a thorough inspection of the ASP—visually inspecting for suspicious munitions and using M8 chemical detector paper and M18A2 chemical detector kits to check for chemical contamination. Visual recognition involves far more than simply looking at munitions. Depending on the country of origin, color codes often indicate the type of munition. In the Gulf War, however, using color codes to determine munition type was not reliable because the Iraqis frequently painted munitions with whatever color was readily available. The physical configuration of a weapon is often a better indication of its use. Chemical munitions must, by their very nature, be built to hold liquids—so their assembly points have filler plugs.<sup>56</sup> It was these cues the EOD team members were looking for during their inspection of the ASP.

Recollections of the EOD team's inspection differ considerably. GySgt Grass remember it this way:

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<sup>53</sup> CENTCOM SPOTREP 282150C, Gulfink

[http://www.dtic.mil:80/...082696\\_DOC\\_133\\_SIG\\_OPS\\_EVENTS\\_35.txt](http://www.dtic.mil:80/...082696_DOC_133_SIG_OPS_EVENTS_35.txt). (The geographic coordinates (geocoords) given correspond to the Universal Transverse Mercator (UTM) grid coordinates recorded in other logs.)

<sup>54</sup> CENTCOM Logs, Gulfink [http://www.dtic.mil/gulfink...centcom/100996\\_nbc\\_024-34.html](http://www.dtic.mil/gulfink...centcom/100996_nbc_024-34.html).

<sup>55</sup> Interview with EOD team member, Lead Sheet 5291, dated June 18, 1997 and CMAT Number 1997153-0000131 and Interview with EOD team member, CMAT Number 1997170-0000026.

<sup>56</sup> Interview with EOD team member, CMAT Number 1997170-0000026; Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively and Interview with EOD team member, Lead Sheet 5291, dated June 18, 1997 and CMAT Number 1997153-0000131.

I watched everything that they did....They went in there and got in their chemical protective equipment....They had a little monitor, a little hand-held kind of machine. I am not sure what that was...and they walked around the area that we showed them and they were writing things down. When they got done, they decontaminated themselves and there was nothing destroyed while I was standing there...They said, yes, you are right. There are chemical weapons stored out there....[but] they were not sent up there to verify that. They were up there to check the lot numbers on the ammunition that was stored up there to...see if those rounds were coming after sanctions were imposed on Iraq.<sup>57</sup>

In contrast, every member of the EOD team categorically denies finding chemical weapons or any evidence of chemical agents in the ASP. The team leader stated: "[t]he only munitions in the ASP were conventional."<sup>58</sup> Every member of the team also denies telling GySgt Grass or any member of his crew otherwise.<sup>59</sup> "No, that would never have been said."<sup>60</sup>

Members of the team recall only one suspicious incident while they were in the ASP. The team was inspecting a stack of artillery munitions that were painted gray, the base color used by many countries to mark some chemical weapons. The munitions were in a puddle of liquid. As a member of the team picked up one of the artillery rounds, the liquid ran down his arm, which was covered by his protective gear. Following standard procedures, the team swiped the liquid with M8 paper and tested with their M18A2 chemical detector kits. Neither of these tests showed positive for the presence of chemical agent. In addition, the EOD team took the ordnance to the Fox vehicle so they could 'sniff' them....The Fox vehicle 'smelled' nothing and the color of the projectile, though similar to U.S. chemical ordnance, was indicative of a Warsaw Pact high-explosive, fragmentation round, so it was ruled condensation from being enclosed in a plastic container and the wide variation in temperatures that we had been experiencing.<sup>61</sup>

According to one EOD team member,

...[t]he Iraqi's did not have the ASP sealed to protect the ammunition from the elements and several stacks of munitions were...sitting in dark puddles of rainwater...[T]o the untrained eye...these stacks could appear to be leaking munitions.

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<sup>57</sup> Testimony of GySgt George Grass, 1 May 96.

<sup>58</sup> Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively.

<sup>59</sup> Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively; Interview with EOD team member, CMAT Number 1997170-0000026; Interview with EOD team member, Lead Sheet 5291, dated June 18, 1997 and CMAT Number 1997153-0000131 and Interview with EOD team member, CMAT Number 1997170-0000025.

<sup>60</sup> Interview with EOD team member, CMAT Number 1997170-0000026.

<sup>61</sup> Letter to Representative Shay, Chairman of the House Government Relations and Oversight Subcommittee from member of EOD team, December 19, 1996, CMAT Number 1997169-0000-054.

After completing their inspections, the EOD team followed GySgt Grass back to the Task Force Ripper headquarters area. The EOD team leader passed the negative results of their inspection to the Task Force Ripper NBC Officer.<sup>62</sup> The EOD team then returned to its unit; there they told the Officer In Charge (OIC) they had not found chemical weapons in the ASP. The team leader filed a Call Sheet to record the inspection.<sup>63</sup> In an effort to find this Call Sheet, we have contacted the 1<sup>st</sup> EOD Platoon Headquarters in Camp Pendleton, CA. After searching their files, the 1<sup>st</sup> EOD Platoon could not find the Call Sheet. Typically, the 1<sup>st</sup> EOD Platoon retains its records for only two years. It is most likely, therefore, that the Call Sheet was destroyed sometime in 1993.<sup>64</sup>

### **Reports Up the Chain of Command**

Task Force Ripper next passed the EOD team's negative results up the chain of command and around the Kuwaiti Theater of Operations (KTO). The 1<sup>st</sup> MarDiv NBC Officer recalls being told by the Task Force Ripper NBC Officer that the EOD team did not discover any chemical weapons in the ASP. The same day, the 1<sup>st</sup> MarDiv NBC Officer received the MM-1 tapes printed in the ASP by the Fox MM-1 operator. Thinking the matter closed, he saw no need to keep the tapes. Although we have tried to find these tapes, their location, and even existence, is unknown. The 1<sup>st</sup> MarDiv NBC Officer believes he either destroyed them or placed them in files that were routinely destroyed after the Gulf War.<sup>65</sup>

At 1920 hours local time on March 1st, CENTCOM received the following SPOTREP:

Suspect chem[ical] munitions bunker in 1<sup>st</sup> MarDiv sector (2914N04515E) checked by EOD – No chem[ical] munitions present.<sup>66</sup>

The CENTCOM logs then recorded those results:

011930 [1<sup>st</sup> MEF NBC Watch Officer] called back. The suspect bunker was checked out thoroughly – no chemical munitions found.<sup>67</sup>

The NBC Operations Summary in the After Action Report of the Army Central Command (ARCENT) VII Corps records the following:

ARCENT reported IMARDIV sent individuals to check suspected chemical munitions storage site (no grid available) on 28 Feb. Initial results of testing indicated mustard agent. An NBC/EOD team re-evaluated the site with more

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<sup>62</sup> Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively.

<sup>63</sup> Interview with 1<sup>st</sup> FSSG EOD Platoon Officer-In-Charge, Lead Sheet 5294, dated May 16-17, 1996, May 21, 1996 and June 18, 1997.

<sup>64</sup> Interview with 1<sup>st</sup> EOD Platoon Representative, Lead Sheet 5334, dated June 24, 1997.

<sup>65</sup> Interview with 1<sup>st</sup> MarDiv NBC Officer, Lead Sheet 5263, dated June 13, 1997.

<sup>66</sup> CENTCOM SPOTREP 011930C, Gulflink

[http://www.dtic.mil:80/...082696\\_DOC\\_133\\_SIG\\_OPS\\_EVENTS\\_32.txt](http://www.dtic.mil:80/...082696_DOC_133_SIG_OPS_EVENTS_32.txt).

<sup>67</sup> CENTCOM Logs, Gulflink [http://www.dtic.mil/gulflink...centcom/100996\\_nbc\\_024-34.html](http://www.dtic.mil/gulflink...centcom/100996_nbc_024-34.html).

sensitive equipment. They determined that no chemical agent was present. Initial readings were result of petrochemical burning.<sup>68</sup>

### **Additional 1/5 Information**

The 1/5 Commander and the NBC Officer do not recall hearing of the EOD team visit to the ASP. The 1/5 remained encamped around the ASP through at least March 2<sup>nd</sup>. According to the Commanding Officer, the Executive Officer and the Assistant Operations Officer, the ASP was never declared off limits or physically cordoned off, but people were warned to stay away from the area. This was, however, due to the significant amount of ammunition in the area, rather than a perceived or suspected chemical threat.<sup>69</sup> Several Marines from the 1/5 did enter the ASP at various times while they were encamped nearby—including the Commander, the NBC Officer, the Assistant Operations Officer and “approximately 25 - 30”<sup>70</sup> others. None of those who entered was higher than Mission Oriented Protective Posture (MOPP) level 2—that is, carrying, but not wearing their protective gloves and mask—while in the ASP. None of the 1/5 personnel interviewed had any physical symptoms consistent with chemical agent exposure after going through the ASP. Additionally, no one, including the Commander (to whom such a thing should have been reported) recalls hearing reports throughout the 1/5 of any symptoms or injuries consistent with exposure to chemical agents.<sup>71</sup>

### **Cleanup of the ASP**

This Ammunition Supply Point (ASP) was dismantled in late fall 1992 or early spring 1993 during cleanup operations in Kuwait.<sup>72</sup> According to the Defense Intelligence Agency (DIA), “during the three-year, post Persian Gulf War ordnance clearance operations in Kuwait, chemical warfare agents were never detected.”<sup>73</sup> Following the war, the Kuwaiti government contracted ordnance-clearing services to rid the country of munitions left by the occupying Iraqi army. Sources involved in the clean-up report that clearance operations, which ran from 1992 to 1994, were methodical and thorough. Seven countries participated in the clean-up: the United States, the United Kingdom, France, Turkey, Egypt, Pakistan and Bangladesh. The designated U.S. sector, which included the ASP/Orchard area, ran 3,000 square kilometers across the country

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<sup>68</sup> ARCENT VII Corps After Action Report, Gulfink

[http://www.dtic.mil/gulfink/db/army/970107\\_sep96\\_decls23\\_0027.html](http://www.dtic.mil/gulfink/db/army/970107_sep96_decls23_0027.html).

<sup>69</sup> Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Assistant Operations Officer, Lead Sheet 5352, dated June 26, 1997; Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Commanding Officer, Lead Sheet 5333, dated June 24, 1997 and Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Executive Officer, Lead Sheet 5338, dated June 25, 1997.

<sup>70</sup> Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Commanding Officer, Lead Sheet 5333, dated June 24, 1997 and Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Executive Officer, Lead Sheet 5338, dated June 25, 1997.

<sup>71</sup> Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Executive Officer, Lead Sheet 5338, dated June 25, 1997; Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines Assistant Operations Officer, Lead Sheet 5352, dated June 26, 1997 and Interview with 1<sup>st</sup> Battalion, 5<sup>th</sup> Marines NBC Officer, Lead Sheet 5370, dated July 1, 1997.

<sup>72</sup> Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively.

<sup>73</sup> Defense Intelligence Agency, IIR 7-717-0082-97, “Iraqi Ordnance Clean-up Operations in Kuwait (U),” (U) - redacted copy, June 1997. This is consistent with testimony presented by Mr. Charles Duelfer representing UNSCOM in testimony to the Presidential Advisory Committee on Gulf War Veterans’ Illnesses on July 29<sup>th</sup>, 1997 in Buffalo, NY. Mr. Duelfer indicated that there is no evidence that chemical weapons were moved into Kuwait.



from Kuwait Bay to the southwestern border. It was the largest and most difficult to clear. All of the nearly 150 U.S. personnel involved in the disposal of unexploded ordnance were U.S. military-trained EOD personnel. EOD field experience for the technicians ranged from eight to 20-plus years.

After careful study, it was determined that special chemical agent detection equipment was not necessary during clean-up operations. Prior to bidding, the U.S. contracting company conducted an extensive survey of the U.S. sector. The survey team, was on the alert for anything that would complicate clearance operations – in particular, agent-filled munitions requiring special disposal procedures....Because the survey team found no evidence of CW agent presence, the company made the business decision to bid, and then to operate, without special equipment.<sup>74</sup>

Once begun, clean-up operations were divided into two distinct stages: reconnaissance and clearance.<sup>75</sup>

During the nine month reconnaissance phase, all discovered ordnance was visually inspected and cataloged. To ease the cataloging effort and ensure complete coverage, the U.S. sector was divided into 36 subsectors, each approximately 80 square kilometers. The unexploded ordnance (UXO) teams used "portable GPS [Global Positioning Satellite] kits and laptop computers to mark, piece-by-piece, subsector-by-subsector, the exact location and type of all ordnance."<sup>76</sup> No chemical weapons were discovered in this phase of clean-up operations.

Following the reconnaissance phase, operations moved on to ordnance clearance. Using the database developed during the reconnaissance phase, teams moved through each subsector and divided all the ordnance. Serviceable ordnance was turned over to the Kuwaiti government. Ordnance selected for destruction was collected at a central location and placed into large berm-enclosed pits. Alertness for "special munitions," including chemical weapons, remained high throughout this phase. It was standard procedure to suspend operations whenever previously un-encountered types of munitions were discovered. Operations were only resumed when teams positively identified and classified each new munition.<sup>77</sup> No chemical weapons were discovered during this phase.

Ordnance selected for destruction was destroyed on a daily basis. No chemical detectors were set up around the demolition area. A "safe area" was set up at a certain distance around the pits during actual demolition—not to protect against possible chemical exposure, but rather to protect

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<sup>74</sup> Defense Intelligence Agency, IIR 7-717-0087-97, "Post-Gulf War Chemical Warfare Detection Methodology Used in Kuwait (U)," (S), June 1997. In addition to this reporting, OSAGWI interviewed the President of the division of the US contracting company responsible for clean-up in the US sector. This interview corroborates DIA's conclusions that no chemical weapons were found in Kuwait after the war. Interview with Division President, Lead Sheet 1288, dated February 11, 1997.

<sup>75</sup> Defense Intelligence Agency, IIR 7-717-0082-97, "Iraqi Ordnance Clean-up Operations in Kuwait," redacted copy, June 1997.

<sup>76</sup> Defense Intelligence Agency, IIR 7-717-0082-97, "Iraqi Ordnance Clean-up Operations in Kuwait," redacted copy, June 1997.

<sup>77</sup> Defense Intelligence Agency, IIR 7-717-0087-97, "Post-Gulf War Chemical Warfare Detection Methodology Used in Kuwait (U)," (S), June 1997.

against fragments from the exploded munitions. The demolition areas were used six nights a week. The same pits were used over and over again—day after day, night after night. UXO personnel entered the area daily to stack ammunition slated for destruction and to set charges. UXO personnel did not wear chemical protective gear during these operations.<sup>78</sup> No chemical injuries were reported by personnel involved in demolition operations.

During the entire course of clearance operations in Kuwait after the war, there were never any reports of chemical weapons being found in the U.S. sector, or indeed anywhere in Kuwait. Additionally, in the three years since the clearance operations were completed, no contractor personnel who worked in the U.S. sector have reported any medical problems related to chemical agents exposure.<sup>79</sup>

The leader of the EOD Team that inspected the ASP/Orchard on March 1, 1991 returned to Kuwait as a civilian and was involved in all phases of the clean-up operations. He returned to the ASP in fall 1992 or early spring 1993 and was involved in its dismantling. During cleanup operations in this ASP, all the bunkers were cleared and the ordnance was divided into serviceable and unserviceable items. UXO personnel did not wear protective gear while working in the ASP, and there were no indications of chemical weapons, agents, or injuries while UXO personnel dismantled the ASP.<sup>80</sup>

## **ANALYSIS OF THE INCIDENT**

### **Presence of Chemical Weapons in Kuwait**

To date we have found no evidence Iraq moved chemical weapons or chemical agents into Kuwait. The Defense Intelligence Agency (DIA) has made the following statement:

Our current understanding is that Iraq did not deploy CW into Kuwait during the Gulf War. The furthest south Iraqi CW has been found is at Khamisiyah, Iraq.<sup>81</sup>

There are several reasons to believe that the Iraqis never deployed CW into Kuwait. First, there is no confirmed evidence that they did so. Neither Kuwait

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<sup>78</sup> Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively.

<sup>79</sup> Defense Intelligence Agency, IIR 7-717-0082-97, "Iraqi Ordnance Clean-up Operations in Kuwait," redacted copy, June 1997 and Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively.

<sup>80</sup> Interview with EOD team leader, Lead Sheets 5259 and 5293, dated June 11, 1997 and May 23, 1996, respectively.

<sup>81</sup> This was confirmed in a statement by Mr. Charles Duelfer, UN Special Commission, to the Presidential Advisory Committee (PAC) on Gulf War Veterans' Illnesses, July 29, 1997. Major Cross of the PAC asked "Do you see any evidence where any weapons were moved from the three lower depots, actually down into Kuwait, maybe brought back at some time?" Mr. Duelfer answered, "We have seen no evidence of that and Iraqis have said that no movements took place other than what is described here." Mr. Duelfer was referring to movements of munitions to and from the depots near Baghdad and the three lower depots, of which the southernmost (and closest to Kuwait and Saudi Arabia) was Khamisiyah.

nor the Explosive Ordnance Disposal (EOD) companies assisting the Kuwaitis have reported finding any CW during cleanup operations. Iraqi troops stationed in Kuwait often did not have the best CW defensive equipment. This indicates they were not prepared to fight in a contaminated environment.

The Iraqis also feared U.S. retaliation if they used chemical weapons and may have decided to use them only if the regime's survival were threatened. This would explain why Iraq deployed CW to Khamisiyah and An Nasiriyah, but not to Kuwait. Finally, Iraq's most well trained and trusted forces, the Republican Guard - who were in Iraq, not Kuwait - were the units best equipped to deliver CW. Therefore, it is reasonable to conclude that any CW were stored behind these forces, not in front of them.<sup>82</sup>

The Central Intelligence Agency (CIA) concurs with DIA's assessment. "We also conclude that Iraq did not use chemical or biological agents nor were any agents located in Kuwait."<sup>83</sup>

In line with these intelligence community assessments, it is highly unlikely there were chemical weapons in this ASP. According to the EOD team, as well as message traffic and log entries from March 1<sup>st</sup>, 1991, no chemical weapons were in the ASP on that day. Once the ground war ended, only Coalition forces - primarily the U.S. and Kuwaiti - had access to this ASP. We have found no records of U.S. forces discovering or destroying chemical weapons in Kuwait between March 1991 and the beginning of cleanup operations in 1992. The ASP was still intact when the leader of the EOD team returned as an unexploded ordnance contractor. The ASP was inspected twice during the reconnaissance and dismantling phases of cleanup operations. No chemical weapons were found at either time. Additionally, we have found no records the Kuwaitis discovering chemical weapons anywhere inside their country after the war. While it is possible they did so and did not report it, it is unlikely. The Kuwaitis would have had no motivation to conceal the presence of Iraqi chemical weapons on their soil and a great deal of incentive to announce their presence, should they have been found.

### **Detector Limitations**

The MM-1 Mass Spectrometer in the Fox vehicles used by U.S. forces during the Gulf War, was a sophisticated detector. However, according to GySgt Grass, when his vehicle received the alarms in the ASP, its detection equipment was operating in the "Air/Hi" (vapor detection) method. This is the least sensitive method of employment. The Fox vehicle was designed primarily to detect residual persistent liquid agents on the ground. While the MM-1 "will respond to vapor...its sensitivity threshold to most chemical warfare agents is well above the militarily significant concentration."<sup>84</sup> That is to say, although the MM-1 can detect chemical agent vapors, an inordinate amount of liquid must be present to create sufficient vapors to cause

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<sup>82</sup> Defense Intelligence Agency Answers to Questions from Office of the Special Assistant for Gulf War Illnesses, June 23, 1997.

<sup>83</sup> Central Intelligence Agency Testimony to Presidential Advisory Committee, 9 Jul 96.

<sup>84</sup> Interview with Subject Matter Expert from Chemical Biological Defense Command, Lead Sheet 748, dated April 30, 1996 and e-mail from same dated July 28, 1997.

the MM-1 to alarm. Such a large amount of liquid agent would have been noticed by the Fox crew and other personnel who inspected the ASP; except for the puddle of rainwater, none of the Marines who entered or inspected the ASP mentioned large puddles of liquid or leaking munitions.

Although GySgt Grass has stated the MM-1 operator did whatever he was trained to do to get and print a full spectrum,<sup>85</sup> we have no information on the procedures the MM1 operator used to print the tapes from the ASP. Without these tapes, it is impossible to determine what the MM-1 alerted for. Unfortunately, as mentioned above, the tapes were lost and probably inadvertently destroyed.

It is possible to retrieve a spectrum from the MM-1 computer, if it is among the last 72 spectra saved in memory. In 1994, in response to questions raised by Congress, the Army dispatched a team of subject matter experts to read the memory of all Operation Desert Storm (ODS) era Fox vehicles. By that time, Fox vehicle #5604 was stationed in Okinawa, Japan. A memorandum prepared by the Army team states:

No spectra or extra substances were found in USMC S/N 5604 which was the vehicle which reported Lewisite and benzyl bromide detections during ODS.<sup>86</sup>

This indicates there were no spectra saved in the MM-1's memory - probably because an MM-1 operator, in the course of routine maintenance, erased all previously performed spectra.

Marines from the 1/5 used Chemical Agent Monitors (CAMs) to check for chemical agents at the ASP/Orchard. According to the Army's Chemical and Biological Defense Command (CBDCOM), the CAM is significantly more effective at detecting Mustard agent than the "Air/Hi" method used by the Fox. (See Table 1) Despite their greater sensitivity, the CAMs detected no chemical agents at the ASP/Orchard.

### **Physical Evidence**

Mustard, the agent named in the first two Fox alarms, is a persistent liquid agent. Indications of its presence should still have been in the ASP when the EOD team inspected it the day after the alarms and when elements of the 1/5 conducted their inspection while encamped in the area. Additionally, several members of the Fox crew recall being outside their vehicle in MOPP-2—that is, carrying, but not wearing, their protective masks and gloves—when they got these alarms. No one recalls any garlic smells indicating mustard agent and none of the exposed crew reported any physical symptoms consistent with exposure to mustard agent. Members of the 1/5 also went through the ASP unprotected; again, there were no reports of a garlic scent or symptoms of mustard agent exposure. Battlefield contaminants—including those from burning oil wells—could have caused the Fox to alarm for the possible presence of mustard.

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<sup>85</sup> Interview with GySgt George Grass, 20 February 1997, p. 61.

<sup>86</sup> Summary of MM-1 Spectra, US Army Chemical Biological Defense Command, 15 Feb 1994. For more information on the reported Lewisite alarm, see the Al Jaber Airfield case narrative.

Benzyl Bromide, the third agent alarmed for in the ASP, is not typically put in weapons and there is no evidence Iraq had developed a delivery method for this agent. As with the mustard alarms, both the Fox vehicle driver and the wheel operator recall the presence of unprotected soldiers (in addition to the Fox vehicle crew) when the MM-1 alerted for this agent. No one, with the exception of the driver, recalls any physical symptoms consistent with exposure to Benzyl Bromide, a tearing agent. The driver recalls feeling a temporary burning sensation on his hand after the Benzyl Bromide alarm. However, this is not consistent with exposure to tearing agents. He believes the short-lived burning sensation to have been a psychosomatic response to the alarm, rather than a symptom of chemical agent exposure.<sup>87</sup> According to experts at the Chemical and Biological Defense Command (CBDCOM), there are several possible explanations for the Benzyl Bromide alarm. "The ions used to identify benzyl bromide could have come from toluene, a common solvent and cyclopentadiene (C5H6), which is used as an insecticide and a fungicide."<sup>88</sup> Toluene, used as a solvent and found in aviation gasoline, could have come from the industrial area located nearby. Cyclopentadiene, a common insecticide, may have been used sometime previously in the orchard area.

## ASSESSMENT

This investigation is not complete, but based on the information available so far, the presence of chemical weapons or agents in the ASP inspected by GySgt Grass's Fox vehicle on February 28, 1991 is judged to be "Unlikely." Based on testimony and interviews with participants it seems certain the Fox MM-1 alerted to the possible presence of S-Mustard and HT-Mustard (both persistent blister agents) as well as Benzyl Bromide (a tearing agent) in the ASP on the 28<sup>th</sup>. The MM-1 operator printed tapes of these alerts. Investigation has failed to turn-up these tapes or determine the procedures used to print them.

According to interviews with members of the Fox crew, as well as Marines from the 1/5 (the unit co-located with the ASP), there were unprotected personnel in the ASP when the Fox vehicle received these alerts. None of these personnel received any chemical injuries or experienced symptoms consistent with the presence of the alerted for chemical agents.

The Fox vehicle commander reported the alerts and passed the MM-1 tapes to his chain-of-command. These tapes have been lost and are believed to have been inadvertently destroyed after the war. Without these MM-1 tapes it is impossible to determine what caused the MM-1 to alarm. However, these alerts to possible contamination in the ASP were well-documented and were reported up the Task Force Ripper and 1<sup>st</sup> MarDiv chain-of-command to CENTCOM.

Based on the reporting of the alerts up the chain-of-command, an EOD team was ordered to re-inspect the ASP the following day, 1 Mar 1991. The EOD team visually inspected the ASP with the assistance of M8/M9 chemical detector paper and the M18A2 chemical detector kit. The M18A2 is a more sensitive detector than the Fox MM-1 in the "Air/Hi" mode. Despite this, the

<sup>87</sup> Interview with Fox #5604 Driver, Lead Sheets 5353 and 5359, dated December 7, 1993, May 31, 1996 and June 27, 1997.

<sup>88</sup> Interview with Subject Matter Expert from Chemical Biological Defense Command, Lead Sheet 748, dated April 30, 1996 and e-mail from same, dated July 28, 1997.

EOD team inspections failed to turn up evidence of the persistent chemical agent Mustard, the tearing agent Benzyl Bromide or any chemical weapons. The negative results of the EOD team inspections were also passed up the chain-of-command to CENTCOM.

In addition to the Fox vehicle and EOD team inspections, Marines from the 1/5 inspected the ASP using Chemical Agent Monitors. As with the M18A2, the CAM is more sensitive than the Fox MM-1 in the "Air/Hi" mode. The 1/5 inspections also failed to turn-up evidence of chemical agents or chemical weapons in the ASP.

The leader of the EOD team that inspected the ASP on March 1, 1991 returned to Kuwait after the Gulf War and was involved in clean-up operations throughout the country, including this ASP. There were no chemical weapons discovered or chemical agents detected at any time during these multi-phased clean-up operations. The U.S. Intelligence Community continues to assess that Iraq never moved chemical weapons into Kuwait.

Given the preceding evidence and analysis, we assess it is unlikely there were chemical weapons or chemical agents in the ASP. Without the MM1 tapes, we cannot definitively say the alarms in the ASP on February 28, 1991 were false positives. However, the evidence suggests the alarms were indeed false positives and were most probably caused by battlefield contaminants, contaminants from the orchard and/or contaminants from a nearby industrial facility. The negative results of the more sensitive EOD tests on March 1, 1991, as well as the CAM inspections conducted by Marines from 1/5, outweigh the Fox alarms on February 28<sup>th</sup>. The Intelligence Community's assessment that Iraq never moved chemical agents or weapons into Kuwait before the war, the absence of physical symptoms among exposed personnel and the absence of chemical weapons discoveries in Kuwait after the war also lend weight to an "unlikely" assessment.

This assessment is tentative, based on the information available to us to date. This case will be reassessed over time in accordance with any new information and feedback from the publication of this narrative.

***This case is still being investigated. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DOD Persian Gulf Task Force Hot Line at 1-800-472-6719.***

## ***TAB A - Acronyms and Glossary***

This provides a listing of acronyms found in this report. Additionally, the glossary section provides definitions for selected technical terms that are not found in common usage.

### **Acronyms**

1/5 .....	First Battalion, Fifth Marines
1/12 .....	First Battalion, Twelfth Marines
5/11 .....	Fifth Battalion, Eleventh Marines
I MEF .....	First Marine Expeditionary Force
AOR .....	Area of Responsibility
ARCENT .....	Army Central Command
ASP .....	Ammunition Supply Point
BW .....	Biological Warfare
CAM .....	Chemical Agent Monitor
CBDCOM .....	Chemical and Biological Defense Command
CENTCOM .....	U.S. Central Command
CIA .....	Central Intelligence Agency
CW .....	Chemical Warfare
DIA .....	Defense Intelligence Agency
DOD .....	Department of Defense
DSC .....	Direct Support Command
EOD .....	Explosive Ordnance Disposal
FSSG .....	Force Support Service Group
GPS .....	Global Positioning Satellite
GySgt .....	Marine Corps Gunnery Sergeant
HMMWV .....	High Mobility Multi-Wheel Vehicle
HT .....	Mustard Agent
IAD .....	Investigations and Analysis Directorate
KTO .....	Kuwait Theater of Operations
MarDiv .....	Marine Division
MOPP .....	Mission Oriented Protective Posture
NBC .....	Nuclear, Biological and Chemical
NBCO .....	Nuclear, Biological and Chemical Officer
NCOIC .....	Noncommissioned Officer In Charge
ODS .....	Operation Desert Storm
OIC .....	Officer In Charge
OSAGWI .....	Office of the Special Assistant for Gulf War Illnesses
S MUSTARD .....	Sulfur Mustard (Blister Agent)
SPOTREP .....	SPOT Report
SWA .....	Southwest Asia
TF Ripper .....	Task Force Ripper
UNSCOM .....	United Nations' Special Commission on Iraq

UXO.....Unexploded Ordnance Disposal  
VOS.....Vehicle Orientation System

## Glossary

### Blister Agents

Mustard (H) gas was used during the later parts of World War I. In its pure state, mustard is colorless and almost odorless. The name mustard comes from earlier methods of production that yielded an impure, mustard or rotten onion smelling product.

Distilled mustard (HD) was originally produced from H by a purification process of washing and vacuum distillation. HD is a colorless to amber colored liquid with a garlic-like odor, it has less odor and a slightly greater blistering power than H and is more stable in storage. It is used as a delayed action casualty agent, the duration of which depends upon the munitions used and the weather. HD is heavier than water, but small droplets will float on the water surface and present a hazard.

Heavily splashed liquid mustard persists one to two days or more in concentrations that produce casualties of military significance under average weather conditions and a week to months under very cold conditions. HD on soil remains vesicant for about two weeks. The persistency in running water is only a few days, while the persistency in stagnant water can be several months. HD is about twice as persistent in sea water.

Mustard acts first as a cell irritant and finally as a cell poison on all tissue surfaces contacted. Early symptoms include inflammation of the eyes; inflammation of the nose, throat, trachea, bronchi and lung tissue; and redness of the skin. Blistering or ulceration is also likely to occur. Other effects may include vomiting and fever that begin around the same time as the skin starts to redden.

Eyes are very sensitive to mustard in low concentrations: skin damage requires a much larger concentration. HD causes casualties at lower concentrations in hot, humid weather, because the body is moist with perspiration. Wet skin absorbs more mustard than does dry skin. HD has a very low detoxification rate; repeated exposures, therefore, are cumulative in the body.

Individuals can be protected from small mustard droplets or vapor by wearing protective masks and permeable protective clothing. The use of



impermeable clothing and masks can protect against large droplets, splashes and smears.

*References: Department of the Army, Navy and Air Force, FM 3-9, Potential Military Chemical/Biological Agents and Compounds and NBC Equipment.*

## **Detection Paper**

Detection paper relies on certain dyes being soluble in chemical warfare agents. Normally, two dyes and one pH indicator are mixed with cellulose fibers in a paper without special coloring (unbleached). When a drop of chemical warfare agent is absorbed by the paper, it dissolves one of the pigments. Mustard agent dissolves a red dye and nerve agent a yellow. In addition, VX (a form of liquid nerve agent) causes the indicator to turn to blue which, together with the yellow, will become green/green-black.

Detection paper can thus be used to distinguish between three different types of chemical warfare agents. A disadvantage with the papers is that many other substances can also dissolve the pigments. Consequently, they should not be located in places where drops of substances such as solvent, fat, oil, or fuel can fall on them. Drops of water produce no reaction.

Depending on the spot diameter and density on the detection paper, it is possible to gauge the original size of the droplets and the degree of contamination.

*Reference: Detection of Chemical Weapons: An overview of methods for the detection of chemical warfare agents; homepage: <http://www.opcw.nl/chemhaz/detect.htm>.*

## **M256A1 Chemical Agent Detection Kit**

The M256A1 kit is a portable, expendable item capable of detecting and identifying hazardous concentrations of chemical agent. The M256 kit is used after a chemical alert to determine if it is safe to unmask. The M256A1 kit has replaced the M256 kit. The only difference between the two kits is that the M256A1 kit will detect lower levels of nerve agent. This improvement was accomplished by using an eel enzyme for the nerve test in the M256A1 kit in place of the horse enzyme used in the M256 kit.

*Reference: Worldwide Chemical Detection Equipment Handbook, p. 430.*

## **Mission Oriented Protective Posture (MOPP)**

The wearing of MOPP gear provides soldiers protection against all known chemical agents, live biological agents, and toxins. MOPP gear consists of the following items:

Overgarment (chemical suit)

Overboots

Mask (gas mask) with hood

Gloves

When a person is wearing MOPP gear, they can not work for very long nor can they work very fast. They may also suffer mental distress as a result of feeling closed in and will also suffer from heat stress and heat exhaustion when working in warm temperatures and at high work rates. The MOPP concept arose from the need to balance individual protection with the threat, temperature, and urgency of the mission.

Commanders can raise or lower the amount of protection through five levels of MOPP. In addition, commanders can exercise a mask-only option.

**MOPP Zero:** Individuals must carry their protective mask with them at all times. Their remaining MOPP Gear must be readily available (i.e., within the work area, fighting position, living space, etc.).

**MOPP Level One:** Individuals wear their overgarment. They must carry the rest of their MOPP gear.

**MOPP Level Two:** Individuals wear their overgarment and overboots and carry the mask with hood and gloves.

**MOPP Level Three:** Individuals wear their overgarment, overboots, and mask with hood. They carry the gloves.

**MOPP Level Four:** Individuals wear all their MOPP gear.

*Source: U.S. Army Field Manual 3-4, Headquarters Department of the Army, Washington DC, 21 October 1985.*

## TAB B - Units Involved

- 7<sup>th</sup> Marine Regiment (Task Force Ripper)

• 1<sup>st</sup> Marine Battalion

- 7<sup>th</sup> Engineers Support Battalion

- 1<sup>st</sup> FSSG EOD Platoon

Department (Chief)

Personnel

Task (Personnel)

Chief

When a person is working in a high temperature environment, they can not work very long before they will suffer from heat stress. Heat stress is a condition where the body's ability to cool itself is overwhelmed. This can result in heat exhaustion or heat stroke. Heat stroke is a life-threatening condition that requires immediate medical attention. The MOPF personnel are trained to recognize the signs and symptoms of heat stress and to provide first aid. They are also trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary.

Personnel can be trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary.

Personnel

MOPF Level One personnel are trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary.

MOPF Level One personnel are trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary.

MOPF Level Two personnel are trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary. The MOPF personnel are trained to provide medical aid if necessary.

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## ***TAB D - METHODOLOGY FOR CHEMICAL INCIDENT INVESTIGATION***

The DOD requires a common framework for our investigations and assessments of chemical warfare agent incident reports, so we turned to the United Nations and the international community which had experience concerning chemical weapons. Because the modern battlefield is complex, the international community developed investigation and validation protocols<sup>89</sup> to provide objective procedures for possible chemical weapons incidents. The standard that we are using is based on these protocols that include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation, or human or animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by an expert panel.

While the DOD methodology for investigating chemical incidents (Figure 7) is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, the methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. The major efforts in this methodology are:

- Substantiate the incident.
- Document the medical reports related to the incident.
- Interview appropriate people.
- Obtain information available to external organizations.
- Assess the results.

Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

To substantiate the circumstances surrounding an incident, the investigator searches for documentation from operational, intelligence, and environmental logs. This focuses the investigation on a specific time, date, and location, clarifies the conditions under which the incident occurred, and determines whether there is "hard" as well as anecdotal evidence. Additionally, the investigator looks for physical evidence that might indicate that chemical agents were present in the vicinity of the incident, including samples (or the results of analyses of samples) collected at the time of the incident.

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<sup>89</sup> "Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction," April 29, 1997. This Chemical Weapons Convention was opened for signature in Paris, France, on January 13, 1993. It has been signed by 165 States and ratified by 93 States (as of June 1997.) It was signed by the U.S. on Jan 13, 1993 and ratified on April 25, 1997. Part XI of the Convention, "Investigations in Cases of Alleged Use of Chemical Weapons," details some of the procedures.

[<http://www.un.org.ch/frames/disarm/distreat/chemical.htm>]

The investigator searches the medical records to determine if personnel were injured as a result of the incident. Deaths, injuries, sicknesses, etc. near the time and location of an incident may be telling. Medical experts should provide information about alleged chemical casualties.

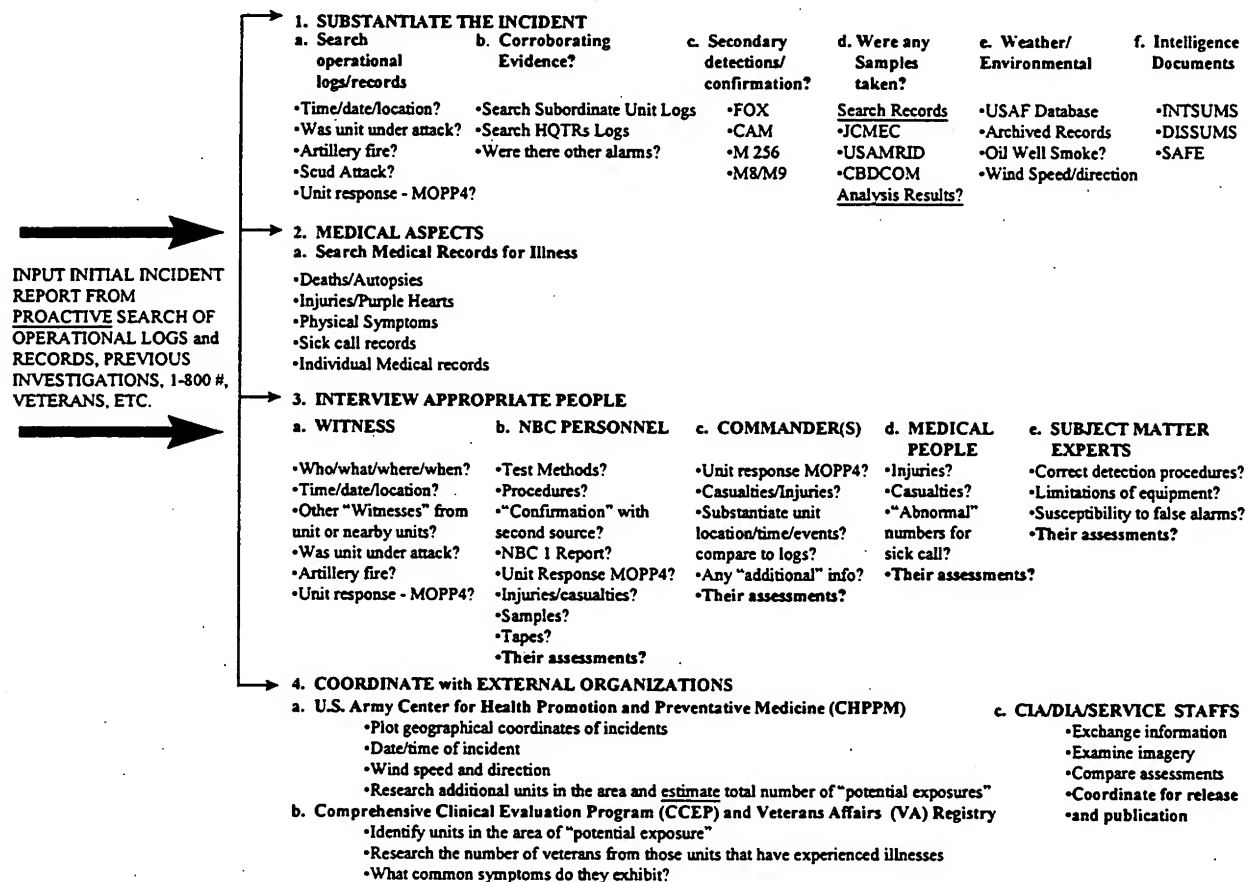


Figure 7. Chemical Incident Investigation Methodology

Interviews of incident victims (or direct observers) are conducted. First-hand witnesses provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved, and are particularly important if physical evidence is lacking. NBC officers or personnel trained in chemical and biological testing, confirmation, and reporting are interviewed to identify the unit's response, the tests that were run, the injuries sustained, and the reports submitted. Commanders are contacted to ascertain what they knew, what decisions they made concerning the events surrounding the incident, and their assessment of the incident. Where appropriate, subject matter experts also provide opinions on the capabilities, limitations, and operation of technical equipment, and submit their evaluations of selected topics of interest.

Additionally, the investigator contacts agencies and organizations that may be able to provide additional clarifying information about the case. These would include, but not be limited to:

1. **RESEARCH DESIGN** - The study was a **cross-sectional** survey of the **general population** of the **United States** in the **year 2000**. The **sample size** was **10,000** individuals, selected using **random sampling** techniques. The **response rate** was **85%**.
2. **MEASUREMENTS AND MAIN RESULTS** - The **primary outcome** was the **prevalence of hypertension**, defined as a **systolic blood pressure** of **140 mmHg or higher** or a **diastolic blood pressure** of **90 mmHg or higher**. The **secondary outcomes** were the **prevalence of diabetes**, **cholesterol levels**, and **smoking status**. The **mean age** of the participants was **45 years**. The **prevalence of hypertension** was **25%**. The **prevalence of diabetes** was **10%**. The **mean cholesterol level** was **200 mg/dL**. The **smoking status** was **20% smokers**, **30% former smokers**, and **50% non-smokers**.
3. **CONCLUSIONS** - The study found that the **prevalence of hypertension** is **high** in the **general population**. The **prevalence of diabetes** is also **high**. The **mean cholesterol level** is **high**. The **smoking status** is **high**. The study suggests that **hypertension** and **diabetes** are **common** conditions in the **general population**. The **mean cholesterol level** is **high**. The **smoking status** is **high**.
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6. **CONCLUSIONS** - The study found that the **prevalence of hypertension** is **high** in the **general population**. The **prevalence of diabetes** is also **high**. The **mean cholesterol level** is **high**. The **smoking status** is **high**. The study suggests that **hypertension** and **diabetes** are **common** conditions in the **general population**. The **mean cholesterol level** is **high**. The **smoking status** is **high**.

evaluation of technical equipment and submit their evaluations of selected pieces of interest.  
- Forensic subject matter experts also provide opinions on the capabilities, limitations and  
- concerns of the events surrounding the incident, and their assessment of the incident. When  
- substantiated, investigators are contacted to ascertain what they know about the incident, they may  
- no further the investigation. The tests that were run, the injuries sustained, and the response  
- personnel trained in chemical and biological testing, toxicology and forensic analysis.

involved, and are particularly important if physical evidence is lacking. While all of the  
- available insight into the conditions surrounding the incident and the status of the environment  
- direct views of incident victims or direct observers are considered, this information is not provided

Additional information about the case. These would include, but not be limited to, a list of living information about the case. These would include, but not be limited to, a list of living information about the case.

# Information Paper

## M8A1 Automatic Chemical Agent Alarm

Information Papers are reports of what we know today about military equipment and/or procedures used in the Gulf War of 1990-1991. This particular information paper on the M8A1 Automatic Chemical Agent Alarm is not an investigative report; instead, it is intended to provide the reader with a basic understanding of chemical detection equipment relevant to several cases currently under investigation. This paper will focus on background information on the M8A1 Alarm System, its components, how it operates, and what could cause it to sound an alarm. This is an interim paper, not a final paper. We hope that you will read this and contact us with any information that would help us better understand the M8A1 Alarm and more accurately report its use during the Gulf War. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997265-0000-016

Last Update: October 30, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1995 to investigate all possible causes. The Investigation and Analysis Directorate (IAD) of the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) assumed responsibility for these investigations on November 12, 1996 and has continued to gather information on the M8A1 Automatic Chemical Agent Alarm, its components, how it operates, and what could cause it to sound an alarm. IAD's interim report is contained here.

As part of the effort to inform the public about IAD's progress, DoD is publishing (on the Internet and elsewhere) accounts related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling the accounts. The following information paper will aid in understanding incidents involving the M8A1 Alarm System during the Gulf War.

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## BACKGROUND

Since the first use of chemical agents in World War I, US military forces have needed a chemical agent detection and warning system. During World War I, many chemical attacks succeeded because troops were unaware of the use of chemicals during battle, had not trained for chemical attacks, and did not possess a chemical detection or warning capability other than their own senses.<sup>1</sup> In 1919, General of the Armies, John J. Pershing, warned that, "Whether or not gas will be employed in future wars is a matter of conjecture, but the effect is so deadly to the unprepared that we can never afford to neglect the question."<sup>2</sup>

The US did not begin to develop a chemical agent detection and warning system until the 1950s—finally fielding the M8 Automatic Chemical Agent Alarm in the late 1970s. By the mid-1980s, technological advances prompted the second generation alarm, the M8A1 Alarm System. This became the US military's primary means of detecting nerve agent vapors and its primary early warning system. Recognizing Iraq might use chemical weapons, US forces used over 12,000 M8A1 Alarm Systems in the Kuwaiti Theater of Operations.<sup>3</sup> Many US forces continue to use the M8A1 Alarm System as their primary warning system and means of detecting nerve agent vapor. In March 1998, the US will start fielding the Automatic Chemical Agent Detector Alarm (ACADA), the next generation of chemical agent detector/alarm.<sup>4</sup>

The purpose of this paper is to provide a basic understanding of the M8A1 Alarm System, its components, how it operates, its capabilities and limitations, and the various causes of false alarms. This paper also provides some eyewitness observations during the Gulf War concerning the use and operation of the M8A1 Alarm System.

## DESCRIPTION

The M8A1 Automatic Chemical Agent Alarm system consists of the M43A1 Detector unit, the M42 Alarm unit, and various power supplies. This system is designed to detect only a narrow spectrum of chemical nerve agent vapor or inhalable aerosol (i.e., G series and VX nerve agents); it does not detect riot control, blister, or blood agents. The M8A1 is a remote, continuous air sampling alarm which automatically detects nerve agent vapors and warns personnel with both

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<sup>1</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 1, Critical Task: 031-504-1008, p. 1-1.

<sup>2</sup> Army Training Circular 3-10, *Commander's Tactical NBC Handbook*, Headquarters, Department of the Army, Washington, DC, September 29, 1994, Chapter 4, p. 4-1.

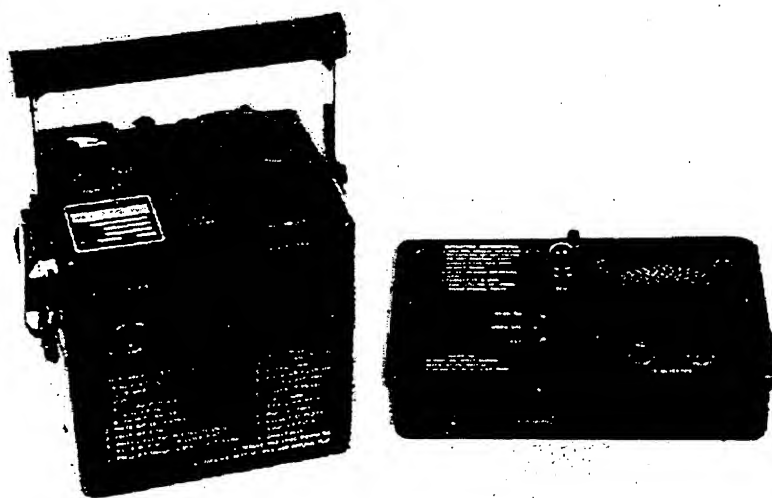
<sup>3</sup> Memorandum, Headquarters, Department of the Army, Office of the Chief of Staff, Washington, DC, SUBJECT: M8A1 Chemical Agent Alarm--INFORMATION MEMORANDUM, June 16, 1997.

<sup>4</sup> Memorandum, Headquarters, Department of the Army, Office of the Chief of Staff, Washington, DC, SUBJECT: M8A1 Chemical Agent Alarm--INFORMATION MEMORANDUM, June 16, 1997. The Date was changed from October 1997 to March 1998 in response to input provided by the Chemical and Biological Defense Command Edgewood, MD, September 18, 1997

audible and visual signals.<sup>5</sup> This system uses the principle of ionization to detect the nerve agent vapor and trigger the alarms. Platoon-level units normally operate the M8A1 Alarm System from a stationary ground position—or mounted in backpacks or on vehicles. Base-level Civil Engineering (CE) Readiness Flight personnel operate the M8A1 for the Air Force. Depending on wind speed, wind direction, terrain, and tactical situation, units should place this system upwind from the unit's farthest position(s) to ensure as much advance warning of a chemical attack as possible.<sup>6</sup> Since so much depends on the M8A1 Alarm System's proper placement, only properly trained operators should place and operate this system.<sup>7</sup> Operators receive proper training through formal classes or a correspondence course (e.g., Army Subcourse CM 7105). Specific details of its battlefield placement will be discussed later in this paper. The Air Force trains equipment operators (CE Readiness personnel) at the Readiness School at Ft. McClellan, AL, at Silver Flag Training sites, and at the CE Readiness Flight level.

### Main Components<sup>8</sup>

Weighing about 14 pounds (including batteries), the M8A1 Alarm System consists of two major



M43A1 Detector

M42 Alarm

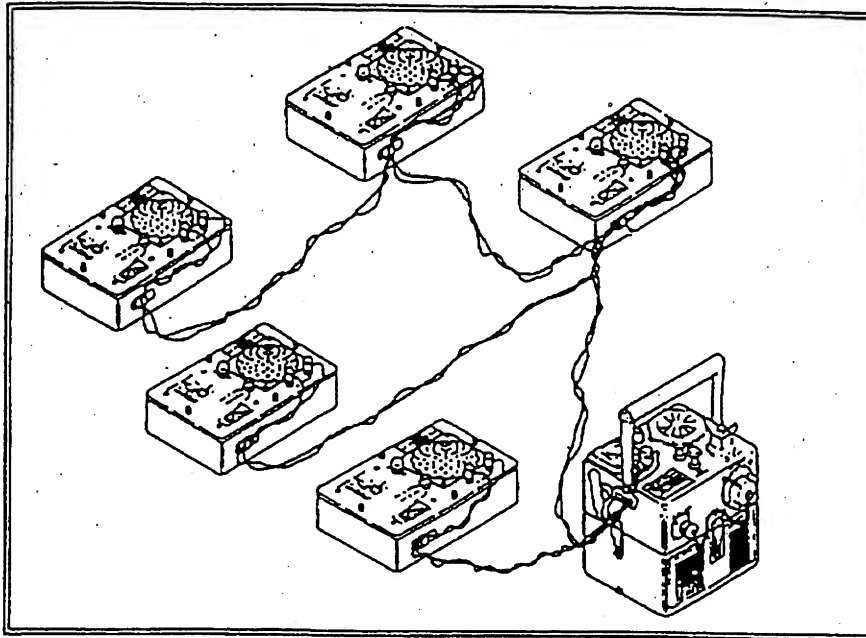
components: the M43A1 Detector unit and the M42 Alarm unit (See Figure 1). The M43A1 Detector unit senses the presence of nerve agent vapor and sounds an alarm (which has an adjustable volume). The M42 Alarm unit, when connected to the M43A1 Detector unit by wire (e.g., telephone cable), provides a remote audible and visual signal (or visual signal only—a flashing red light) whenever the Detector

Figure 1. M8A1 Automatic Chemical Agent Alarm<sup>9</sup>

<sup>5</sup> *Worldwide Chemical Detection Equipment Handbook*, Chemical and Biological Defense Information Analysis Center, Aberdeen Proving Ground, MD, Oct. 95, p. 412, and *Medical Management of Chemical Casualties Handbook*, US Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, MD, Sep. 95, p. 166.

<sup>6</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 4, Critical Task: 031-504-2002, p. 4-16.

<sup>7</sup> *Worldwide Chemical Detection Equipment Handbook*, Chemical and Biological Defense Information Analysis Center, Aberdeen Proving Ground, MD, Oct. 95, p. 414.



unit senses nerve agent vapor. As many as five Alarm units can be connected to one Detector unit (Figure 2), enabling more personnel to hear or see the alarm. When linked to the Detector unit, all M42s alarm simultaneously. Specific details of this system's placement will be discussed in more detail later in this paper.

Figure 2. Five M42 Alarm Units Connected to an M43A1 Detector Unit <sup>10</sup>

### **Additional Required Equipment<sup>11</sup>**

The basic system also includes various power supplies to operate the overall system and its individual units, as well as support equipment:

#### Power Supplies

- When the Detector unit is hand carried or backpacked, it requires a 36 volt DC alkaline battery as its power source.
- The M42 Alarm unit requires four regular D Cell batteries as its power source.
- The M8A1 Alarm System requires a power supply that converts 115 or 220 volts of alternating current (AC) to 30 plus or minus 6 volts of direct current (DC) when the system is used in a fixed emplacement.

<sup>8</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 1, Critical Task: 031-504-1008, p. 1-3 - 1-15.

<sup>9</sup> Memorandum, Headquarters, Department of the Army, Office of the Chief of Staff, Washington, DC, SUBJECT: M8A1 Chemical Agent Alarm--INFORMATION MEMORANDUM, June 16, 1997.

<sup>10</sup> Reconstructed Figure. Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 2, Figure 2-4, Critical Task: 031-504-1008, p. 2-15.

<sup>11</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 1, Critical Task: 031-504-1008, p. 1-8 - 1-14.



## Support Equipment

- The M273 Maintenance Kit contains replacement parts: 10 spare inlet dust filters and 10 test paddles.<sup>12</sup>
- Wire (similar to telephone wire) connects the M43A1 Detector unit to the M42 Alarm unit.
- Mounting Kits vary depending on whether the operator uses the system in a wheeled vehicle, a tracked vehicle, or in a backpack.

## OPERATIONAL DETAILS

### How the M43A1 Detector Unit works<sup>13</sup>

The Detector unit detects nerve agent vapor through a process of ionization (Figure 3).<sup>14</sup> As a pump draws air and any contaminants through the cell module, the air and contaminant molecules pass over a radioactive source and break up into charged pieces called ions. These ions then travel into the baffle section where the lighter and less stable air ions filter out. The collector then senses the current given off by the heavier ions formed from any nerve agent vapor. An electronic module, which monitors the collector, triggers the alarm when it senses a current change that matches the critical concentration of nerve agent.<sup>15</sup>

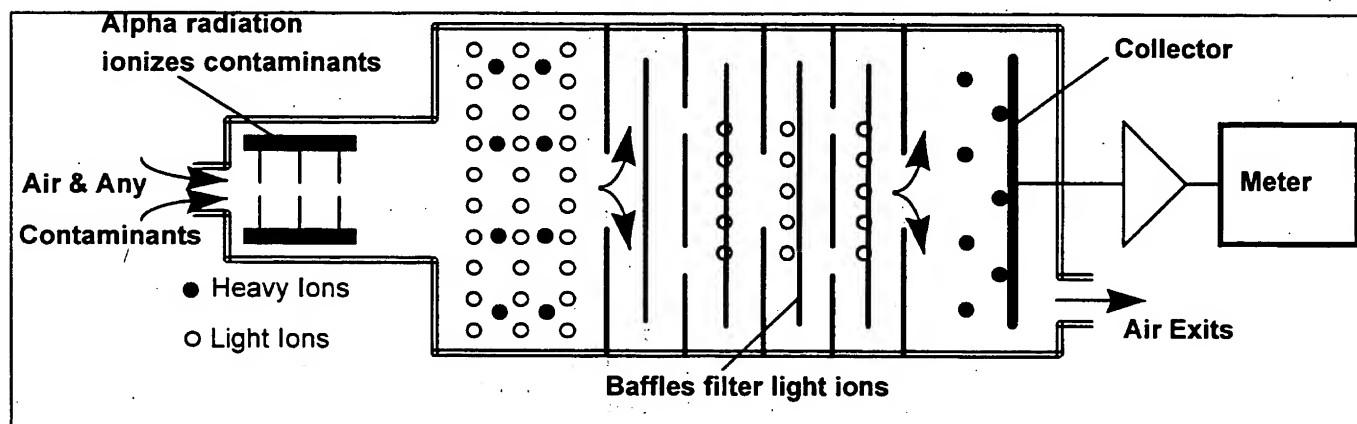


Figure 3. M43A1 Detector Unit's Ion Cell Module<sup>16</sup>

<sup>12</sup> The test paddles contain agent simulant which the operator uses to test the system.

<sup>13</sup> *Worldwide Chemical Detection Equipment Handbook*, Chemical and Biological Defense Information Analysis Center, Aberdeen Proving Ground, MD, Oct 95, p. 413.

<sup>14</sup> Ionization is "the formation of one or more ions by the addition of electrons to or the removal of electrons from an electrically neutral atomic or molecular configuration by heat, electrical discharge, radiation, or chemical reaction. Ions make up molecules." *The American Heritage Dictionary of English Language*, New College Edition, Houghton Mifflin Company, Boston, 1976, p. 690. Ions have a small electric charge that can be detected.

<sup>15</sup> M8A1 Alarm System's nerve agent (vapor form) detection sensitivity: G series = 0.1mg/m<sup>3</sup> to 0.2 mg/m<sup>3</sup> and VX = 0.4 mg/m<sup>3</sup>. G series nerve agents include Tabun (GA), Sarin (GB), and Soman (GD). *Worldwide Chemical Detection Equipment Handbook*, Chemical and Biological Defense Information Analysis Center, Aberdeen Proving Ground, MD, Oct 95, p. 413.

<sup>16</sup> Reconstructed Figure. Briefing chart, CBDCOM, PM NBC Defense, Aberdeen Proving Grounds, MD.

## Placement<sup>17</sup>

When a military unit arrives in an area it plans to occupy (or is already in place at a Chemical/Biological High Threat Area during increased readiness postures), the M8A1 Alarm System operator should immediately put the system into place—determining its exact positioning after first considering wind speed, wind direction, terrain, and the tactical situation. The number of detectors and alarms used will vary depending on the type of unit and the tactical situation. A company-size unit will usually deploy with five M8A1 Alarm Systems.<sup>18</sup> Unless unusual circumstances or limitations exist (e.g., severe terrain features, a shortage of wire, etc.), the operator should place the M43A1 Detector unit(s) a maximum of 150 meters upwind from the farthest unit position. Since the alarms will go off in less than two minutes after a detection, placing this system at least this far away will allow enough time for personnel to take appropriate protective measures (e.g., putting on all Mission Oriented Protective Posture garments and mask, and verifying the alarm with two M256A1 Chemical Agent Sampler Detectors).

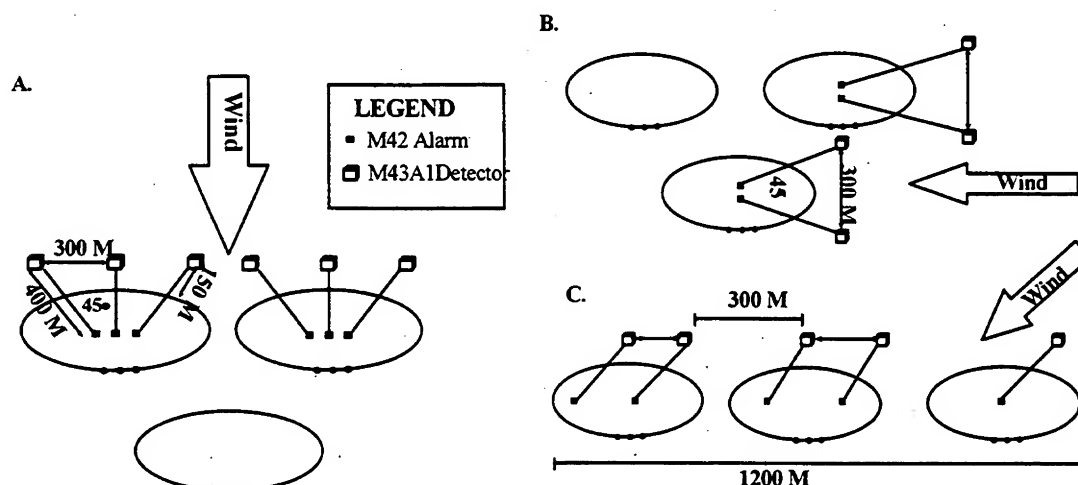


Figure 4. Placement of M8A1 Alarm System<sup>19</sup>

To minimize the possibility of nerve agent vapor drifting through gaps in the detector array, operators should place the M43A1 Detector units no more than 300 meters apart. To ensure that the electric signal remains strong enough to activate the alarms, operators should place the Detector units no more than 400 meters from the M42 Alarm units (Figure 4). To ensure proper positioning and proper maintenance, operators should receive training through formal classes or a correspondence course (e.g., Army Subcourse CM 7105).

<sup>17</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lessons 4, Critical Task: 031-504-2002, p. 4-1 - 4-18.

<sup>18</sup> The actual number of alarms a unit deploys with is dependent on the type unit it is and where it will be located within the theater of operations. A company sized unit may have anywhere from 4 to 6 alarms.

<sup>19</sup> Reconstructed Figure. Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 4, Figures 4-13, 4-14, and 4-15, Critical Task: 031-504-1008, p. 4-17, 4-18.

A typical Air Force base requires adequate detection for the immediate 3x5 kilometer area. In order to achieve 5 minutes of warning with a 90% detection certainty, operators use a "Dice 5" pattern—laying out approximately 35 detectors 750 to 1500 meters apart. (The "Dice 5" pattern mimics the dot pattern on the fifth side of a die.) To protect personnel from chemical agents within key facilities, detectors are also used inside the perimeter.

## Maintenance

To ensure the proper and continued operation of the M8A1 Alarm System, its operators must perform preventive maintenance checks and services (PMCS). PMCS is a series of mandatory equipment inspections and operational procedures, specified in the M8A1 Alarm System's technical manuals. Operators perform these inspections before, during, and after operating (including troubleshooting) the system, its components, and ancillary equipment. When operators fail to properly inspect and maintain the M8A1 Alarm System, they increase the chance of false alarms from clogged filters, low batteries, or improper set up. Operators should note any observed deficiencies on the appropriate maintenance forms to ensure that these deficiencies are corrected. This paper will not discuss the step-by-step details of PMCS, nor its start-up and shut-down procedures, but will provide a general overview of each phase of PMCS and certain operations.

- **Before-Operations Checks:**<sup>20</sup> During this check, the operator inspects the M8A1 Alarm System internally and externally—including components and ancillary equipment—for cleanliness, damage, or any other defect (e.g., missing parts). Among other things, the operator must check seals for leaks, ensure that the air flow through the detector is within the designated range, check the batteries for sufficient voltage, test the audible signals (or horns),<sup>21</sup> and ensure that the detector is capable of sensing a nerve agent simulant.<sup>22</sup> During before-operations checks, the operator should pay close attention to all operational cautions and warnings in the technical manual or on the data plates to properly prepare the system for operation.
- **Start-up and Operational Procedures:**<sup>23</sup> After completing the before-operations checks, the operator can place the M8A1 Alarm System into operation using a step-by-

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<sup>20</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 2, Critical Task: 031-504-1008, Table 2-1, p. 2-4 - 2-12.

<sup>21</sup> Procedures specify that whenever the operator tests the M8A1 Alarm System's audible signal, the operator must warn as many personnel as possible that this is a test and not an actual alarm.

<sup>22</sup> The US Army specified special handling and disposition instructions in the event the ion cell module becomes damaged at any time. Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Critical Task: 031-504-1008, Introduction.

<sup>23</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 2, Critical Task: 031-504-1008, p. 2-13 - 2-16.

step procedure detailed on the exterior data plates of both the M43A1 Detector and M42 Alarm units. If starting cold, the Detector unit can take up to 15 minutes to warm up.

- **During-Operations Checks:**<sup>24</sup> While in operation, the operator must check the system periodically to ensure that it is operating properly. One periodic check is a 24-hour reservice check. The operator must also conduct another check every time the system is reactivated after an operational alarm. (The operator conducts this check in response to the system's alarm and to verify the cause of the alarm—i.e., the presence of nerve agent vapor). If the operator suspects a chemical attack, individuals take immediate protective measures as proscribed by doctrine and standard unit procedures (including upgrading the unit's MOPP and decontaminating the system). If a chemical agent is verified, the system must be decontaminated. Once the operator decontaminates the system, start-up procedures commence again. The operator repeats start-up procedures and during-operations checks until the unit commander determines the area to be clear (usually after two negative M256A1 Chemical Agent Detection Kit results).
- **Operations under Unusual or Severe Conditions:**<sup>25</sup> Operators must follow special M8A1 Alarm System operational procedures when operating this system under unusual or severe conditions. Unusual or severe conditions include: blowing dust or sand; rain, sleet, or snow; temperatures below -40°F and above 120°F; humidity equal to 3-100 percent relative humidity; fording; and emergency operations undertaken with broken controls or indicators. While operating under unusual or severe conditions, operators may have to change batteries and filters more often than usually required.<sup>26</sup>
- **Shut-down Procedures (After-Operations Checks):**<sup>27</sup> After shutting down the system—and to prepare it for storage—the operator should make an internal and external inspection of the system (including its main components and ancillary equipment) for cleanliness, damage, and other defects. During these procedures, the operator should pay particular attention to removing, storing, and/or destroying the Detector's outlet filter as explained in the technical manual.

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<sup>24</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 2, Critical Task: 031-504-1008, p. 2-16 - 2-20.

<sup>25</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 2, Critical Task: 031-504-1008, p. 2-20 - 2-23.

<sup>26</sup> JULLS Number: 42366-78000(00016), submitted by 2/58<sup>th</sup> Aviation Regiment/Message, CDRXVIII Airborne Corps, P100748Z Sep 90, SUBJECT: NBC - M8A1 Chemical Alarm Batteries (U). and CDRXVIII Airborne Corps, P211500Z Sep 90, SUBJECT: M8A1 Chemical Agent Alarm (U).

<sup>27</sup> Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lesson 3, Critical Task: 031-504-1008, p. 3-10 - 3-4.

## FALSE ALARMS

Even if the operator follows all the proper procedures, the M8A1 Alarm System may not be 100% effective—due in part to its operational design limitations or its detection sensitivity. Like all chemical warfare agent detectors, the M8A1 must balance its sensitivity (ability to sense the presence of nerve agent vapor) with its selectivity (its ability to avoid sensing chemicals other than nerve agents). Designed to provide the maximum warning time to unprotected troops, the M8A1 was designed to be very sensitive (Table 1).

Table 1. M8A1 Alarm System Detection Sensitivity<sup>28</sup>

Agent Class	Agent(s)	Detection Sensitivity (in vapor form)
Nerve	G Series	0.1 mg/m <sup>3</sup> to 0.2 mg/m <sup>3</sup>
	VX	0.4 mg/m <sup>3</sup>

Unfortunately, increasing sensitivity reduces selectivity and soldiers suffer false alarms from a number of interferents that form ionized products similar to those of nerve agents. Many chemical compounds used in either a normal or a military operational environment (i.e. diesel, gasoline exhaust, burning fuel, etc.) can cause this system to false alarm. Examples of known interferents are shown in Table 2.

Table 2. M8A1 Alarm System Interferents<sup>29</sup>

<ul style="list-style-type: none"><li>• Heavy concentration of rocket propellant smoke</li><li>• Green smoke grenades</li><li>• Diesel and gasoline exhausts (engine/vehicle)</li><li>• Gasoline and JP8 (a clear fuel) vapor</li><li>• Burning JP4 (a fuel), JP8, oil, and kerosene</li><li>• Insecticides (e.g., Diazinon and Malathion)</li></ul>	<ul style="list-style-type: none"><li>• Paint fumes</li><li>• Floor wax</li><li>• Perfumes</li><li>• Cologne</li><li>• After-shave</li><li>• Cigarette smoke</li></ul>
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Additionally, operating in unusual or severe environmental conditions for which the system was not designed could also cause false alarms. For example, during the Gulf War, high temperatures and sand concentrations often caused this system to false alarm.<sup>30</sup> Operating in unusual or severe

<sup>28</sup> Reconstructed Table. G series nerve agents include Tabun (GA), Sarin (GB), and Soman (GD). *Worldwide Chemical Detection Equipment Handbook*, Chemical and Biological Defense Information Analysis Center, Aberdeen Proving Ground, MD, Oct 95, p. 413.

<sup>29</sup> Memorandum, Headquarters, Department of the Army, Office of the Chief of Staff, Washington, DC, SUBJECT: M8A1 Chemical Agent Alarm--INFORMATION MEMORANDUM, June 16, 1997, Army Subcourse CM7105, *Operation and Maintenance of the M8A1 Automatic Chemical Agent Alarm System*, The Army Institute for Professional Development, US Army Chemical School, Fort McClellan, AL, June 1992, Edition A, Lessons 1 and 2, Critical Task: 031-504-1008, p 1-2 and 2-18, and *Worldwide Chemical Detection Equipment Handbook*, Chemical and Biological Defense Information Analysis Center, Aberdeen Proving Ground, MD, Oct 95, p. 414.

conditions can drain the system's power sources, especially the batteries. In turn, low batteries can cause a false alarm.

## OBSERVATIONS FROM DESERT STORM

The M8A1 Chemical Alarm System was widely used during Desert Storm, where it encountered a decidedly hostile environment. Because of the number of M8A1 Alarm Systems used, there is considerable feedback from those who actually worked with the system:

- "...adverse operations were conducted under adverse field conditions. From the Saudi berm north, the air was heavy with oil smoke. This smoke deposited an oily residue on the alarms' paddles which tripped the alarms. The M8A1s were useless in the smoky, dusty desert environment."<sup>31</sup>
- "Units instructed to keep aircraft clear of launch sites...chemical alarms alerting; chemical survey of the area produced negative results and it was determined to be a false alarm caused by emplacing the M8 too close to vehicle exhausts. Units were advised of the possibility of false alarms from the source."<sup>32</sup>
- "...many M43A1 Detectors (a component of the M8A1) are sounding an alarm due to heavy concentrations of sand and engine exhaust, etc. These alarms cannot be reset which results in them being turned in for high level maintenance...change TM [Technical Manual] to provide detailed instructions on operators purging of the M43A1."<sup>33</sup>
- "M8A1 Alarm batteries were only good for 30-32 hours in the desert environment compared to its normal 72 hours."<sup>34</sup>
- "Many false alarms due to a low battery caused units to unnecessarily upgrade their protective posture and may have desensitized soldiers to a real hazard. The M8A1 Alarm should have an alternate low battery alarm/signal. This would allow units to immediately identify an alarm as a low battery warning."<sup>35</sup>

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<sup>30</sup> Memorandum, Headquarters, Department of the Army, Office of the Chief of Staff, Washington, DC, SUBJECT: M8A1 Chemical Agent Alarm--INFORMATION MEMORANDUM, June 16, 1997.

<sup>31</sup> MCLLS Number: 22754-24000 (00029) submitted by 2d LAIBN, March 23, 1991, SUBJECT: M8A1 NBC Alarms.

<sup>32</sup> Message, XVIII Airborne Corps, April 10, 1991, SUBJECT: AAR-1<sup>st</sup> Cavalry Div Command Report.

<sup>33</sup> Message, FORSCOM, FT MCPHERSON GA//FCJ3-CAT//O071123Z Sep 90, SUBJECT: Purging M8A1 Chemical Agent Alarm.

<sup>34</sup> JULLS Number: 42366-78000(00016), submitted by 2/58<sup>th</sup> Aviation Regiment/Message, CDRXVIII Airborne Corps, P100748Z Sep 90, SUBJECT: NBC--M8A1 Chemical Alarm Batteries (U).

<sup>35</sup> JULLS Number 52058-77115 (00009), submitted by Division Chemical, 24<sup>th</sup> Infantry Division, SUBJECT: Lessons Learned.

During the Gulf War, the M8A1 Chemical Alarm System encountered many of the interferents (oily smoke, blowing sand, extreme temperatures, etc.) that cause it to false alarm. Because of the system's sensitivity, combined with the conduct of daily maintenance during which the alarm system's audible signal might also have been tested, the M8A1 alarms frequently sounded -- so frequently that some soldiers lost confidence in the alarms, or worse, turned them off.

## CONCLUSION

The M8A1 Chemical Alarm system is a useful tool for detection of chemical warfare nerve agent vapors and was used extensively by US troops during Operation Desert Storm. In order to improve troop safety and assure alerting for nerve agent vapors, the US government accepted the possibility of the increased occurrence of false alarms. Critical design considerations allowed for initial false alerts that, because of the environment of the desert, were much higher than many soldiers expected. Based on inputs from commanders and lessons learned from Desert Storm, improvements will be incorporated into the M22 Automatic Chemical Agent Detector Alarm (ACADA) in March 1998—eventually replacing the M8A1 Alarm System.<sup>36</sup> This new detector will sense both nerve and mustard agent vapors, and is expected to have fewer false alarm responses to many known interferents—especially gasoline and diesel exhausts.

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<sup>36</sup> Memorandum, Headquarters, Department of the Army, Office of the Chief of Staff, Washington, DC, SUBJECT: M8A1 Chemical Agent Alarm--INFORMATION MEMORANDUM, June 16, 1997. The date October 1997 reflected in the Memorandum was changed to March 1998 due to input from CBDCOM on September 18, 1997

## ***TAB A - Acronym Listing/Glossary***

This TAB provides a listing of acronyms found in this report. Additionally, the Glossary section provides definitions for selected technical terms that are not found in common usage.

### **Acronyms**

AAR.....	After Action Review
AC.....	Alternating Current
ACADA.....	Automatic Chemical Agent Detector Alarm
CBD COM.....	Chemical and Biological Defense Command
DC.....	Direct Current
DoD.....	Department of Defense
FORSCOM.....	Forces Command
IAD.....	Investigation and Analysis Directorate
JULLS.....	Joint Universal Lessons Learned System
LAIBN.....	Light Armored Infantry Battalion
MCULLS.....	Marine Corps Lessons Learned System
MOPP.....	Mission Oriented Protective Posture
OSAGWI.....	Office of the Special Assistant for Gulf War Illnesses
PM.....	Product Manager
PMCS.....	Preventive Maintenance Checks and Services
TM.....	Technical Manual
US.....	United States

### **Glossary**

#### **Chemical Agent**

A chemical substance which, by its physiological effects, is intended for use in military operations to kill, seriously injure, or incapacitate people. Excluded from this definition are riot control agents, herbicides, smoke, and flame.

Source: FM 3-9/NAVFAC P-467/AFR 355-7, Headquarters, Department of the Army, Department of the Navy, and Department of the Air Force, Washington, DC, February 1, 1996.

#### **GulfLINK**

A World Wide Web site maintained by the Office of the Assistant to the Deputy Secretary of Defense for Gulf War Illness (<http://www.gulflink.osd.mil>).

#### **Ionization**

Ionization is the process of breaking molecules into smaller pieces. Each piece has an electric charge that can be detected.



Mission Oriented  
Protective Posture  
(MOPP)

MOPP is a flexible system of donning and removing chemical protective garments and mask (also called MOPP Gear) in order to balance mission requirements with the chemical threat. The wearing of chemical protective garments and mask provides soldiers protection against most known chemical agents, biological agents, and toxins. Personnel in MOPP Level 0 wear no MOPP Gear, but carry their protective mask; while personnel in MOPP Level 4 wear all MOPP Gear. MOPP Gear consists of the following items: overgarments (chemical suit), overboots, butyl rubber gloves, and protective mask with hood.

Source: US Army Field Manual 3-4, Headquarters, Department of the Army, Washington, DC, October 21, 1985.

M256A1 Chemical  
Agent Detection Kit  
(M256A1 Kit)

The M256A1 Kit is a portable, expendable item capable of detecting and identifying hazardous concentrations of nerve, blood, and blister agent. The M256A1 Kit is used after a chemical attack to determine if it is safe to unmask. This kit replaced the M256 Kit. The only difference between the two kits is that the M256A1 Kit will detect lower levels of nerve agent. This improvement was accomplished by using an eel enzyme for the nerve agent test in the M256A1 Kit in place of the horse enzyme used in the M256 Kit.

Source: *Worldwide Chemical Detection Equipment Handbook*.

Nerve Agents

Chemical agents (e.g., G series and VX), that when inhaled, ingested, or absorbed into the body through the skin, inhibit cholinesterase enzymes throughout the body. This inhibition causes acetylcholine, which transmits nerve impulses, to build up at various sites and block nerve impulses. The major effects are uncoordinated muscular contractions, fatigue, eventual paralysis, pinpointed pupils, tightness in the chest, nausea, vomiting, diarrhea, runny nose, drooling, thought pattern disturbances, convulsions, coma, and death.

Source: FM 3-9/NAVFAC P-467/AFR 355-7, Headquarters, Department of the Army, Department of the Navy, and Department of the Air Force, Washington, DC, Dec. 12, 1990.

## ***TAB B - Bibliography***

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Message, FORSCOM, FT MCPHERSON GA//FCJ3-CAT//O071123Z Sep 90, SUBJECT: Purging M8A1 Chemical Agent Alarm.

Message, XVIII Airborne Corps, April 10, 1991, SUBJECT: AAR 1<sup>st</sup> Cavalry Div Command Report.

Message, XVIII Airborne Corps, P211500Z Sep 90, SUBJECT: M8A1 Chemical Agent Alarms.

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*Worldwide Chemical Detection Equipment Handbook*, Chemical and Biological Defense Information Analysis Center, Aberdeen Proving Ground, MD, Oct 95.

# **Case Narrative**

## **Reported Detection Of Chemical Agent Camp Monterey, Kuwait**

Case Narratives are reports of what we know today about specific events that took place during and after the Gulf War of 1990 and 1991. This case narrative focuses on the reported detection of chemical agents at Camp Monterey, Kuwait. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding the reported detection at Camp Monterey. Please contact my office to report any new information by calling:

**1-800-472-6719**

**Bernard Rostker**  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997118-0000-033

**Last Update: May 15, 1997**

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War Illnesses. In response to veterans' concerns, the Department of Defense (DoD) established an Investigation Team in June 1995 to look into all possible causes. The Investigation and Analysis Directorate (IAD) of the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) assumed responsibility for these investigations on November 12, 1996, and has continued to investigate reports of positive chemical agent detections such as that at Camp Monterey. The interim report on this detection is contained here.

As part of the effort to inform the public about the progress of this effort, DoD is publishing on the Internet and elsewhere accounts related to possible causes of Gulf War Illnesses, along with whatever documentary evidence or personal testimony was used in compiling the account. The narrative that follows is such an account.

## SUMMARY

This narrative reports the events and investigation surrounding the reported detection of a chemical agent in Camp Monterey, Kuwait. The Camp Monterey detection was investigated based on information provided by a contractor employee responsible for maintaining the mobile mass spectrometry chemical analysis equipment on Fox reconnaissance vehicles under US Central Command's control during Operations Desert Shield/Storm.

On September 16, 1991, two Fox reconnaissance vehicles were called in response to two soldiers becoming sick after spilling the contents of a small metal can at Camp Monterey, Kuwait. The detection equipment in the Fox reconnaissance vehicles sounded alarms for the possible presence of Sarin (GB), a nerve agent. Both Fox reconnaissance vehicles then performed complete spectrum analyses, and both vehicles identified the compound in question as o-chlorobenzylidene malononitrile (CS), a riot control agent. Later, copies of tape print-outs of both readings were submitted to the Persian Gulf War Veterans' Illnesses Investigation Team (PGIIT).<sup>1</sup> In order to obtain conclusive and objective analyses of the tapes, the PGIIT forwarded them to three expert laboratories: the Army Chemical and Biological Defense Command (CBDCOM), Bruker Analytical Systems, Inc., and the National Institute of Standards and Technology (NIST), for independent analyses. All three reviews confirmed that the Fox spectra readings detected the presence of CS, not Sarin. The reviews also explained why the initial Sarin alarms were consistent with the design of the chemical detection system in Fox reconnaissance vehicles. Additionally, one of the Fox reconnaissance vehicle operators reported that cans moved from the detection site contained a white powder, which is consistent with the physical properties of CS and not consistent with those of Sarin (which is a colorless liquid or vapor).

## NARRATIVE (An acronym listing is at Tab A)

### About Camp Monterey<sup>2</sup>

Camp Monterey is located about 15 miles north of Kuwait City and about 7 miles south of the Iraqi border<sup>3</sup> as shown in Figure 1. Camp Monterey is the American name given to a Kuwaiti Brigade headquarters taken by the Iraqis in August 1990 and used as an Iraqi Corps headquarters. The area was partially destroyed by US and Coalition bombing during the Air War in January

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<sup>1</sup> The PGIIT is the predecessor organization for the Office of the Special Assistant for Gulf War Illnesses, Investigations and Analysis Directorate.

<sup>2</sup> The Army colonel who was the commander of Camp Monterey at the time of this incident provided the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) with a video tape which was made to send to family and friends of troops stationed at Camp Monterey in order to convey the environment in which the troops lived-- one of safe preparedness. This video, made after this incident had occurred, does not mention the chemical agent detections or indicate the building in which the chemical agents were found. The still images captured from this video show the Camp Monterey environment. Additional photos of Camp Monterey were provided to OSAGWI by another veteran stationed at Camp Monterey.

<sup>3</sup> Camp Monterey is located in the vicinity of geographical coordinates 29° 40' 38" N, 47° 48' 51" E. USCINCENT SITREP, November 12-18, 1991.

1991. The first US unit to occupy the camp was the US Army 4th Squadron, 7th Cavalry Regiment of the Combat Aviation Brigade, 3rd Armored Division in March 1991. Later, in June 1991, the 11th Armored Cavalry Regiment based at Camp Doha outside Kuwait City used the area as a forward camp for training exercises in northern Kuwait. In August 1991, as part of Task Force Victory, the 3rd Battalion of the 77th Armor Regiment of the 8th Infantry Division moved to the camp and was the only US force between Iraq and Kuwait City. While the 3/77 Armor Battalion was the only combat unit at Camp Monterey, there were engineering units stationed there, as well, that were involved in recovery operations.<sup>4</sup>

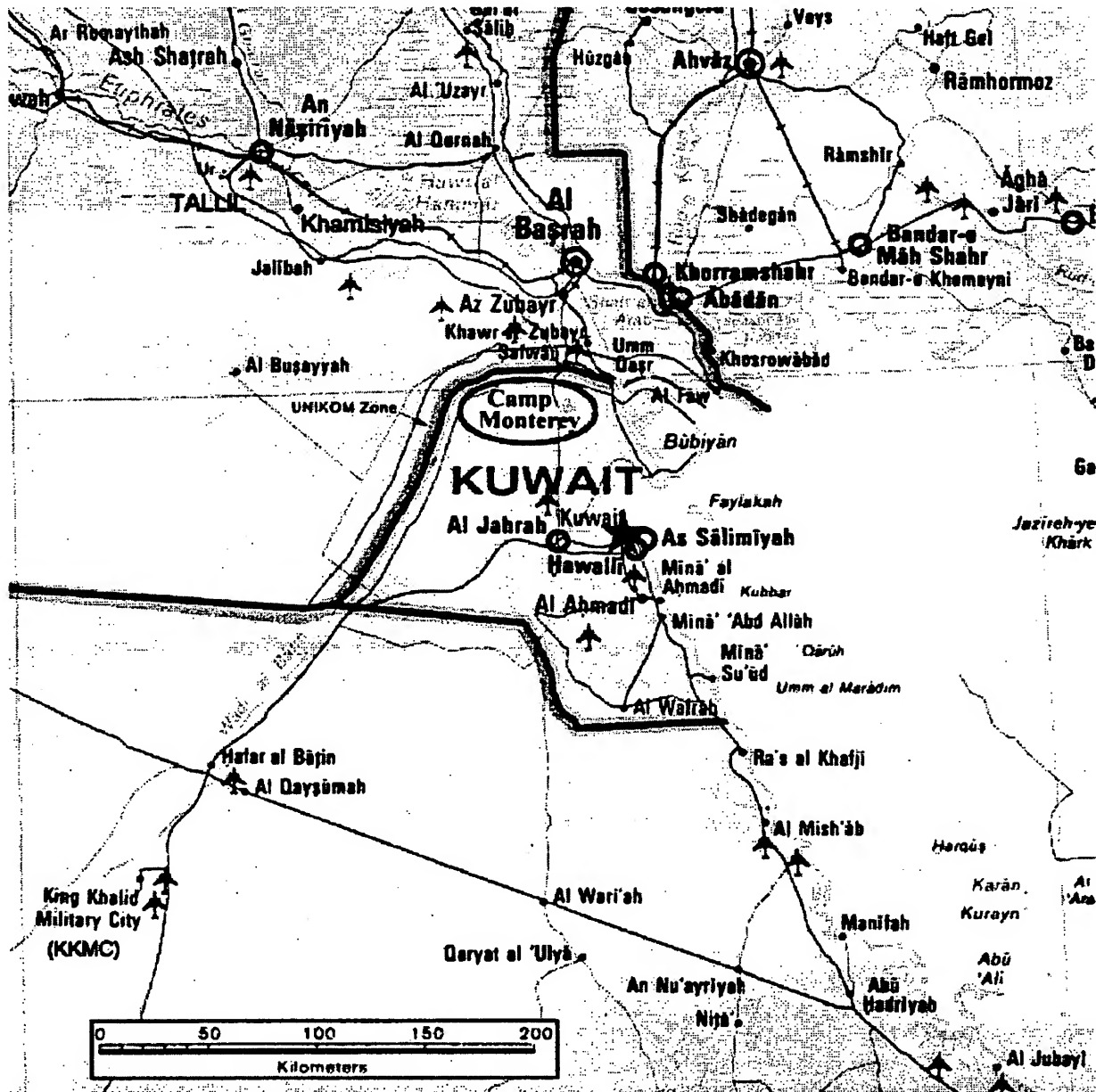


Figure 1. Kuwait Theater of Operations: Camp Monterey

<sup>4</sup> Pathfinder Record Number 837, Subject: Preface to the Final Chapter Closeout AAR.

## Detection of Chemical Agents at Camp Monterey

On the morning of September 16, 1991, US Army troops from Task Force Victory 3/77 Armor at Camp Monterey were moving wooden crates containing metal cans out of a building so that the building could be used to house US troops.<sup>5</sup> One of the cans broke and spilled white powder. Two soldiers became sick in the presence of the substance, experiencing tearing and eye irritation symptoms as well as nausea. A Fox reconnaissance vehicle<sup>6</sup> was sent to the site because it was suspected that a chemical agent might be present. The vehicle's initial inspection alerted for Sarin (GB), a nerve agent which is colorless in liquid or vapor form and may cause death within 15 minutes if there is a severe exposure.<sup>7</sup> The Camp Monterey commander was informed of these findings immediately; he asked for a second Fox reconnaissance vehicle to confirm the findings. The second Fox reconnaissance vehicle detection system was operated by the first operator in order to ensure that the same procedures were followed by both vehicles. The second vehicle, whose calibration was checked, alerted for Sarin, but also alerted for o-chlorobenzylidene malononitrile, commonly known as CS. CS, an irritant agent used for riot control, is a white crystalline solid with a pungent, pepper-like odor and is stable under ordinary conditions of storage.<sup>8</sup> In accordance with established procedure, full spectrum analyses were run by both vehicles, and both identified the chemical as CS, not Sarin. Because of the detection of CS, the area was secured. Both soldiers involved in the incident were examined immediately following exposure, later that day, and the next morning. The soldiers were diagnosed to be fully recovered with no recurring symptoms. According to the commander, "everybody was OK."<sup>9,10</sup>

## Investigation

Although the chemical compound was identified at the time as CS by the full spectrum analyses of the two Fox reconnaissance vehicles, the Persian Gulf Veterans' Illnesses Investigation Team conducted an investigation of the incident in response to a letter from a lawyer representing a contractor employee responsible for maintenance for the mobile mass spectrometry chemical analysis equipment on Fox reconnaissance vehicles under US Central Command's control during Operations Desert Shield/Storm.

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<sup>5</sup> Accounts of the detection are provided in interviews with the commander of the 3/77 Armor, 8 Infantry Division, V Corps and with an operator of the Fox reconnaissance vehicles. The interviews are documented in Lead Sheets 1137 dated November 7, 1996 and 1214 dated January 3, 1997, respectively. Lead Sheet 1214 lists the soldiers present at the incident who were members of the units listed in Tab B.

<sup>6</sup> A description of the Fox and the detection capabilities of its mass spectrometry chemical detection system is found in *Fox Reconnaissance Vehicles*, Office of the Special Assistant for Gulf War Illnesses, May 1997. In particular, this document describes the procedures for initial inspections and full spectrum analyses.

<sup>7</sup> Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries, US Army Field Manual FM8-285, February 28, 1990. Chapter 2. Skin and eye toxicities are defined for Sarin in *Jane's NBC Protection Equipment*, page 15, as "0.28 mg/kg by mouth and 0.05 mg/kg by eye."

<sup>8</sup> Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries, US Army Field Manual FM8-285, February 28, 1990. Chapter 7.

<sup>9</sup> Lead Sheet 1137.

<sup>10</sup> The IAD is in the process on contacting the soldiers involved in this incident to follow-up on this diagnosis.

In his letter, the lawyer stated:

Between 10:17 am and 10:33 am on [September 16] the enclosed tape shows that the first vehicle detected Sarin (GB) with eight (8) readings. Both the air monitor and surface monitor showed Sarin nerve gas as present. The air monitor showed concentrations of 3.0 - 4.0 and the surface monitor showed concentrations of 5.6.

The U.S. Army Brigade Commander for the area was informed of these findings. He asked for a second Fox vehicle to confirm the findings. A second vehicle arrived, and having checked its calibration... it also detected Sarin at noon on that date... at a 5.2 concentration.

The mass spectrometers that produced these readings in the two Fox vehicles were not faulty and were fully calibrated. As you know, the Fox vehicle mass spectrometer was the most sophisticated chemical detection equipment available to the U.S. Army to detect on-site chemical agents. In view of the ongoing investigation of the Persian Gulf illnesses and exposure to Iraqi chemical agents, we look forward to an investigation of the clear exposure incident and the personnel involved and the state of their health.<sup>11,12</sup>

The tapes mentioned were copies of the tape printouts of the mass spectrometry chemical detection system, the MM1, used on the Fox reconnaissance vehicle which had been retained by the contractor employee. In order to obtain conclusive and objective analyses of the tapes, the Investigation Team forwarded copies of the Fox spectra tapes to three independent mass spectrometry experts at the US Army Chemical and Biological Defense Command, Bruker Analytical Systems, Inc.-- the manufacturer of the chemical detection system in the Fox, and the National Institute of Standards and Technology (NIST), for analyses. The Investigation Team also interviewed one of the operators of the Fox reconnaissance vehicles, the Camp Monterey commander, and the contractor employee,<sup>13</sup> who was present in the first Fox reconnaissance vehicle and provided the Fox spectra readings. All three expert reviews confirmed that the initial Sarin detection was a false positive and that the full spectrum analyses of both Fox reconnaissance vehicles correctly identified the riot control agent CS.<sup>14</sup>

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<sup>11</sup> Letter to the Persian Gulf Investigation Team, September 11, 1996.

<sup>12</sup> The meaning of these detection concentrations is outlined in the *Fox Reconnaissance Vehicles*, Office of the Special Assistant for Gulf War Illnesses, May 1997.

<sup>13</sup> The interview with the contractor employee is documented in the Lead Sheet 1125 dated October 28, 1996. See also Lead Sheet 960 dated September 17, 1996 regarding contact with the contractor employee's lawyer to arrange interview with the contractor employee.

<sup>14</sup> Lead Sheet 941.



## ***US Army Chemical and Biological Defense Command Analysis***

The US Army Chemical and Biological Defense Command responded:

Both MM1 tapes indicate valid detections of the riot control compound known as CS. We assign a high confidence level to this conclusion....

[The] initial response of the first MM1 was an alarm to the chemical warfare compound GB (Sarin). From the tape copies provided, we cannot determine whether CS was being monitored for in the wheel high method as the monitor list for this method was not printed out or not provided. In any case, as prescribed by proper Fox NBC Reconnaissance procedures on detection of a chemical warfare compound, the operator programmed the MM1 to take a spectrum of the compound detected. The MM1 then automatically searches its entire library of chemical warfare compounds for the best match of that spectrum. The MM1 then correctly identified the compound as CS, a riot control agent. It must be understood that for a number of complex technical reasons, the MM1 sometimes incorrectly identifies the compound being sampled when it is monitoring in the air monitor mode. For this reason, the spectrum procedure is prescribed to assure correct identification after the initial response.<sup>15</sup>

### ***Bruker Analytical Systems, Inc. Analysis***

Bruker Analytical Systems, Inc., the manufacturer of the mass spectrometer used in the Fox reconnaissance vehicles, also confirmed that the initial alert for Sarin was false and that the full spectrum analyses correctly detected the riot control agent CS. The report states:

I have looked at the tapes you have supplied in your FAX of 28 September 1996, and can state without a doubt that the substance was CS and not Sarin.<sup>16</sup>

Bruker explained that the two main reasons for the initial detection of Sarin are: (1) the monitor modes compare detections of only four ions against a limited target list; and (2) the detector's interference parameter is set such that no false alarms will be suppressed for extremely dangerous compounds such as Sarin.

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<sup>15</sup> CS was in fact on the monitor list, as seen in the copy of the tapes included in Letter to the Persian Gulf Investigation Team, September 11, 1996. The quote is taken from the Memorandum from the Office of the Project Manager for NBC Defense Systems, Subject: Evaluation of MM1 Tapes, October 23, 1996.

<sup>16</sup> Report from Bruker Analytical Systems, Inc., Subject: Analysis of MM-1 Data for Sarin False Alarm and CS Identification, October 2, 1996, p 1.

Regarding the first factor, the Bruker report states:

In either Air or Surface Monitor Modes, the MM-1 has a TARGET COMPOUND LIST that it is looking for. It is simply monitoring the intensities of the 4 ions in the list of compounds selected. IT IS IGNORING ALL OTHER IONS IN THE SPECTRA.

This means that it is rapidly searching for a fingerprint consisting of 4 ions for each compound... While this mode results in high sensitivity and rapid response, it is important to realize that the accepted legal criteria for identification of compounds by mass spectrometry (for example in EPA methods), requires that a COMPLETE SPECTRUM OF ALL IONS PRESENT be provided. This is one reason why ANY alarm must be verified by the FULL SPECTRUM even though the spectrum will not be as fast to alarm.<sup>17</sup> (emphasis original)

In other words, by comparing only four ions against a limited target list, the identity of a sampled compound may be quickly limited to a "short list" of candidates from the target list, allowing the Fox to quickly sound an alarm. By running a full spectrum analysis, the chemical agent may be identified uniquely from the complete list of chemicals in the detector's databanks, allowing the Fox to confirm or refute the alarm.

The second factor reported by Bruker is the interference parameter:

The interference parameter suppresses false alarms due to LARGE amounts of other substances present. Since in Air Monitor mode, only a certain list of compounds are monitored, if the ions of one of the other compounds monitored are present in large amounts, then the alarm is suppressed. This blocks false alarms resulting from minor peaks present in the spectra. In this case, if the difference between the largest ion monitored and the ions of CS ions is greater than 10 ([inverse] log 1.0) the alarm is suppressed. For Sarin, the difference must be [inverse] Log 8.0 or 100,000,000. This is typically used to suppress false alarms from petroleum oil in the background. The MM-1 has a dynamic range of Log 8. THIS MEANS THAT WITH AN INTERFERENCE OF 8 FOR SARIN, NO FALSE ALARMS WILL BE SUPPRESSED IN THE PRESENCE OF LARGE AMOUNTS OF OTHER COMPOUNDS- IN THIS CASE CS. Since the standard procedure calls for taking a complete spectra and verifying the identification, some false alarms in Air Monitor mode are accepted by the Army to INSURE that there are NO FALSE NEGATIVES where a dangerous agent such as Sarin would not be

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<sup>17</sup> Report from Bruker Analytical Systems, Inc., Subject: Analysis of MM-1 Data for Sarin False Alarm and CS Identification, October 2, 1996, pp 2-3.

detected. In the case of CS, [an] Interference of 1.0 means that the alarm may be suppressed due to the presence of other ions.<sup>18</sup> (emphasis original)

In other words, the US Army uses an interference parameter which is set sufficiently high to ensure that an alarm will sound for extremely dangerous compounds like Sarin in the presence of large amounts of other compounds, like CS. Alternatively, for compounds such as CS, the interference parameter may be set low to prevent false alarms in the presence of large amounts of other compounds.

Moreover, regarding this particular combination of compounds, the Bruker report states:

With the interference and reliability parameters used, it is expected that CS in such high concentration, would give an alarm for Sarin and indicate a lower concentration. This is why a full mass spectrum is considered necessary to identify a substance by mass spectrometry in a court of law. Likewise, this is also why the standard procedure the soldiers are taught for operation of the MM-1 REQUIRES a spectrum for verification. There is no firm identification UNLESS the spectrum identifies the agent. As an analogy, alarming in Air Monitor Mode is equivalent to standing on the side of the road with your eyes closed and identifying makes and models of automobiles passing by the sound of the engine. Spectrum Mode would be equivalent to opening your eyes and seeing the license number, color, and make/model of the automobiles in addition to listening to the engine.<sup>19</sup> (emphasis original)

### *NIST Analysis*

In agreement with the above analyses, NIST<sup>20</sup> stated that the mass spectra from the two Fox reconnaissance vehicles "are clearly diagnostic of CS-- there is no evidence of Sarin. The very low threshold settings for Sarin relative to CS provide a credible explanation of why Sarin was reported [and] was a false identification."<sup>21</sup> The threshold settings, here, refer to the interference parameter discussed above.

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<sup>18</sup> Report from Bruker Analytical Systems, Inc., Subject: Analysis of MM-1 Data for Sarin False Alarm and CS Identification, October 2, 1996, p 2.

<sup>19</sup> Report from Bruker Analytical Systems, Inc., Subject: Analysis of MM-1 Data for Sarin False Alarm and CS Identification, October 2, 1996, p 5.

<sup>20</sup> NIST is an authority in mass spectrometry. One ongoing NIST effort is to develop a mass spectral database "containing every compound in commerce" which will define standard "finger prints" to identify compounds using a mass spectrometer. NIST Homepage, Chemical Science and Technology, NIST/EPA/HHH Mass Spectral Database.

<sup>21</sup> Letter from NIST Mass Spectrometry Data Center, October 7, 1996.

## *Interviews*

The Fox reconnaissance vehicle operator interviewed by the Investigation Team reported sighting a short brown can, approximately 8" in diameter. He observed a white powder substance inside.<sup>22</sup> The description of the can was consistent with that given by the contractor employee, who was present in the first Fox reconnaissance vehicle; however, the contractor employee was unable to identify the state of matter (solid, powder, liquid) of the substance inside.<sup>23</sup> The Camp Monterey commander confirmed the sequence of events as described by the Fox reconnaissance vehicle operator and reported that the contractor employee had confirmed that the Fox reconnaissance vehicles were correctly calibrated and that the agent detected was CS at the time of the incident. The Camp Monterey commander also said that his unit's physician's assistant reported that everyone was fine, and that there was no evidence of nerve agent exposure.<sup>24</sup>

Results of the investigation were provided to the contractor employee's lawyer.<sup>25</sup> No further inquiries into the matter have been made by the attorney.

***This case is still being investigated. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DoD Persian Gulf Task Force Hot Line at 1-800-472-6719.***

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<sup>22</sup> Lead Sheet 1214.

<sup>23</sup> Lead Sheet 1125.

<sup>24</sup> Lead Sheet 1137.

<sup>25</sup> Letter from the Office of the Secretary of Defense, November 5, 1996. See also Memorandum to Assistant Secretary of Defense (Health Affairs) from Director Persian Gulf War Veterans' Illnesses Investigation Team, Subject: Response ... Concerning Possible Release of Sarin at Camp Monterey, Kuwait on 16 September 1991, dated October 16, 1996.

## ***Tab A - Acronyms***

CBDCOM .....	Chemical and Biological Command
CINCCENT .....	Commander in Chief for Central Command
CS .....	O-chlorobenzylidene Malononitrile
EPA .....	Environmental Protection Agency
GB .....	Sarin
NBC .....	Nuclear, Biological, and Chemical
NIH .....	National Institute of Health
NIST .....	National Institute of Standards and Technology
OSAGWI .....	Office of the Special Assistant for Gulf War Illnesses
PGIIT .....	Persian Gulf Illnesses Investigation Team
SITREP .....	Situation Report
US .....	United States

***Tab B - Units Involved***

- US Army 3rd Battalion, 77th Armor Regiment, 8th Infantry Division, V Corps
- US Army 2nd Battalion, 29th Field Artillery Regiment, 42nd Field Artillery Brigade, V Corps
- US Army 4th Fox Platoon, 25th Chemical Company, 8th Infantry Division, V Corps

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Lead Sheet 960, September 17, 1996.

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Letter to the Persian Gulf Investigation Team, September 11, 1996.

Letter from NIST Mass Spectrometry Data Center, October 7, 1996.

Memorandum from Office of the Project Manager for NBC Defense Systems, Subject: Evaluation of MM1 Tapes, October 23, 1996.

Memorandum to Assistant Secretary of Defense (Health Affairs) from Director, Persian Gulf War Veterans' Illnesses Investigation Team, Subject: Response ... Concerning Possible Release of Sarin at Camp Monterey, Kuwait on 16 September 1991, October 16, 1996.

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# Case Narrative

## Kuwaiti Girls' School

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on events at the Kuwaiti Girls' School. Both UK and US military elements received positive alarms for chemical warfare agent in a storage tank located outside the school wall. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding events at the Kuwaiti Girls' School. Please contact the appropriate office to report any new information by calling:

**UK: 0171-218-4462**

**US: 1-800-472-6719**

Edgar Buckley,  
Assistant Under Secretary (Home & Overseas)  
UK Ministry of Defence

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
US Department of Defense

1998071-0000009

Last Update: March 11, 1998

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DOD) established a task force in June 1995, to investigate all possible causes. The Investigation and Analysis Directorate (IAD) of the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) assumed responsibility for these investigations on November 12, 1996, and has continued to investigate the events that occurred at the Kuwaiti Girls' School in the Al Ahmadi district of Kuwait. In addition, the Persian Gulf War Illnesses Task Force (PGWITF), consisting of members of the various US intelligence services, provided information and expert analysis to the IAD on a multitude of issues arising from the IAD's investigation into events at the Kuwaiti Girls' School.

Early in 1997, the British Government established a Gulf Veterans' Illnesses Unit (GVIU) within the Ministry of Defence (MOD), to coordinate the UK's response to all of the issues raised by Gulf veterans' illnesses. In July 1997, the British Government published a policy statement detailing its strategy for addressing veterans' concerns. The Government pledged to investigate incidents where chemical or biological warfare agents were alleged to have been present or detected. The incident at the Kuwaiti Girls' School was the first such case to be reviewed.



As part of the effort to inform the public about the progress of its efforts, DoD and MOD are publishing (on the Internet and elsewhere) accounts relating to particular incidents which Gulf War veterans have reported and which could have a bearing on the illnesses now being suffered by Gulf war veterans, along with whatever documentary evidence or personal testimony was used in compiling the accounts. The narrative that follows is such an account. Its production has been coordinated with several key individuals involved in events at the Kuwaiti Girls' School. US personnel directly coordinating with investigators on this narrative's production are Major Michael Johnson, Lieutenant Colonel Donnie Killgore, and Colonel (Ret.) John Macel. UK coordination has been with the Sampling Team Leader, Major John Watkinson, and the British soldier injured during testing. While these six individuals directly reviewed and commented on draft versions of this document, numerous others provided key information which helped investigators to provide a more comprehensive view of events surrounding the Kuwaiti Girls' School. We appreciate their assistance and encourage others with additional information to contact us.

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## METHODOLOGY

During and after the Gulf War, people reported that they had been exposed to chemical warfare agents. To investigate these incidents, and to determine if chemical weapons were used, the DoD developed a methodology for investigation and validation based on work done by the United Nations and the international community where the criteria include:

- A detailed written record of the conditions at the site
- Physical evidence from the site such as weapons fragments, soil, water, vegetation or human/animal tissue samples
- A record of the chain of custody during transportation of the evidence
- Testimony of eyewitnesses
- Multiple analyses
- Review of the evidence by experts.

While the DoD methodology (TAB C) for investigating chemical incidents is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Therefore, we cannot apply a rigid template to all incidents, and each investigation must be tailored to its unique circumstances. Accordingly, we designed our methodology to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence. The MOD has conducted its investigation along similar lines, relying on documentary evidence and the testimony of key eyewitnesses.

By following our methodology and accumulating anecdotal, documentary, and physical evidence, and by interviewing eyewitnesses and key personnel, and analyzing the results, the investigator can assess the validity of the presence of chemical warfare agents on the battlefield. Because information from various sources may be contradictory, we have developed an assessment scale (Figure 1) ranging from "Definitely" to "Definitely Not" with intermediate assessments of "Likely," "Unlikely," and "Indeterminate." This assessment is tentative, based on facts available as of the date of the report publication; each case is reassessed over time based on new information and feedback.

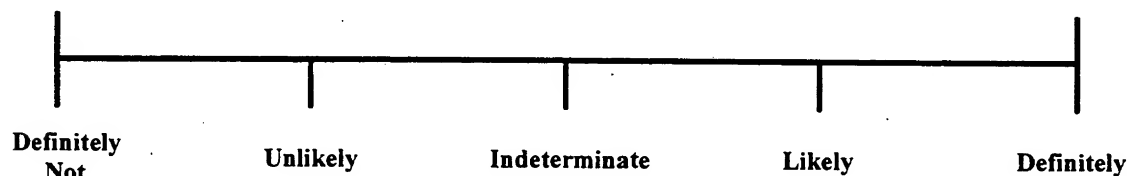


Figure 1. Assessment of Chemical Warfare Agent Presence

The standard for making the assessment is based on common sense: do the available facts lead a reasonable person to conclude that chemical warfare agents were or were not present? When insufficient information is available, the assessment is "Indeterminate" until more evidence can be found.

## SUMMARY

This Case Narrative provides information concerning significant events relating to the discovery and testing of a storage tank suspected of containing chemical warfare agent. The reported discovery and testing of the storage tank, which was located next to the outside wall of the Kuwaiti Girls' School in Kuwait City, Kuwait, took place in early August 1991. Both UK and US military elements tested the contents of the tank. Concern over the contents of the tank, coupled with the overlap in jurisdiction at the national and organizational level, resulted in four separate operations being conducted at the tank. These operations were carried out under the command of Major John Watkinson, 21<sup>st</sup> EOD Squadron, British Royal Engineers, as the UK had overall responsibility for EOD clearance in the area in which the tank was located. Various elements of 21<sup>st</sup> EOD Squadron along with other US and UK elements conducted these operations. The operations were as follows: 1) Major Watkinson's testing, 2) the Fox vehicle testing, 3) sampling of the tank, and 4) permanent sealing of the tank. These operations were not necessarily conducted by the same individuals and these individuals were not always aware of the other operations. This meant that some individuals ended their involvement with limited information and unanswered questions about the nature of the tank's contents. For a brief listing of the major individuals and organizations involved in the testing of the tank's contents see TAB E. For graphical representations of the involvement of the key individuals and organizations, see TABs F and G.

During these four operations, multiple tests were conducted using several chemical detectors, including two Fox nuclear, chemical and biological reconnaissance vehicles. Many of these tests gave positive indications for mustard agent, with the two Fox vehicles alarming for phosgene as well. A contemporary press report in the British newspaper *The Sunday Observer* also covered the story and reported that a container full of mustard agent had been discovered in Kuwait City.

In 1994, when Iraqi chemical weapons were suggested as a possible cause of Gulf War illnesses, events at the Kuwaiti Girls' School became a focus of government and media scrutiny. After reviewing materials provided by the Department of Defense, including the data from multiple positive tests and hearing the testimony of those involved in testing the tank, the Senate Committee reviewing the incident concluded that chemical warfare agent was present in the storage tank. In the United Kingdom, Parliamentary questions born out of the US Senate Committee examination have repeatedly been raised.

A joint US-UK investigation, which began in 1997, uncovered evidence indicating the events at the Kuwaiti Girls' School in 1991 were not as simple as they seemed, nor were the results of the on-site 1991 testing definitive. Included in this evidence was a copy of the Fox vehicles' mass spectrometer tapes from the testing on August 9, 1991, as well as analysis of samples taken from the tank for laboratory testing, both of which were passed on request to DoD by the UK Ministry of Defence (MOD) in 1997. Analysis of the Fox

mass spectrometer tapes by military chemical experts at the Edgewood Research, Development, and Engineering Center (ERDEC), molecular weight experts at the National Institute of Standards and Technology (NIST), and the manufacturer of the mass spectrometer used on the FOX, definitively and consistently shows that no known chemical warfare agent was present in the tank. Analysis of the Fox tapes did, however, indicate the presence of inhibited red fuming nitric acid (IRFNA). In addition, 1991 British analysis of samples taken from the tank stated that "the samples were entirely consistent with the contents of the tank being nitric acid."

Our investigation has unearthed further evidence which significantly bolsters the assessment that it was nitric acid not chemical warfare agent in the tank. Research revealed that Iraqi forces used the school as a test and maintenance facility for SILKWORM anti-ship missiles, which use IRFNA as their fuel oxidizer. This provides a plausible reason for positioning the tank at the school. In addition, the physical descriptions of the substance provided by those directly involved were not indicative of any known chemical warfare agent but are consistent with the presence of IRFNA.

Based on currently available information, we assess that chemical warfare agent was "definitely not" present in the storage tank at the Kuwaiti Girls' School. We also assess that IRFNA "definitely" was present in the tank.

We further assess that all personnel involved in the testing of the tank at the Kuwaiti Girls' School performed their duties in an exemplary manner. The equipment utilized by UK and US Armed Forces operated as it was designed, and all technical resources were employed properly.

## NARRATIVE

### Background of the Kuwaiti Girls' School

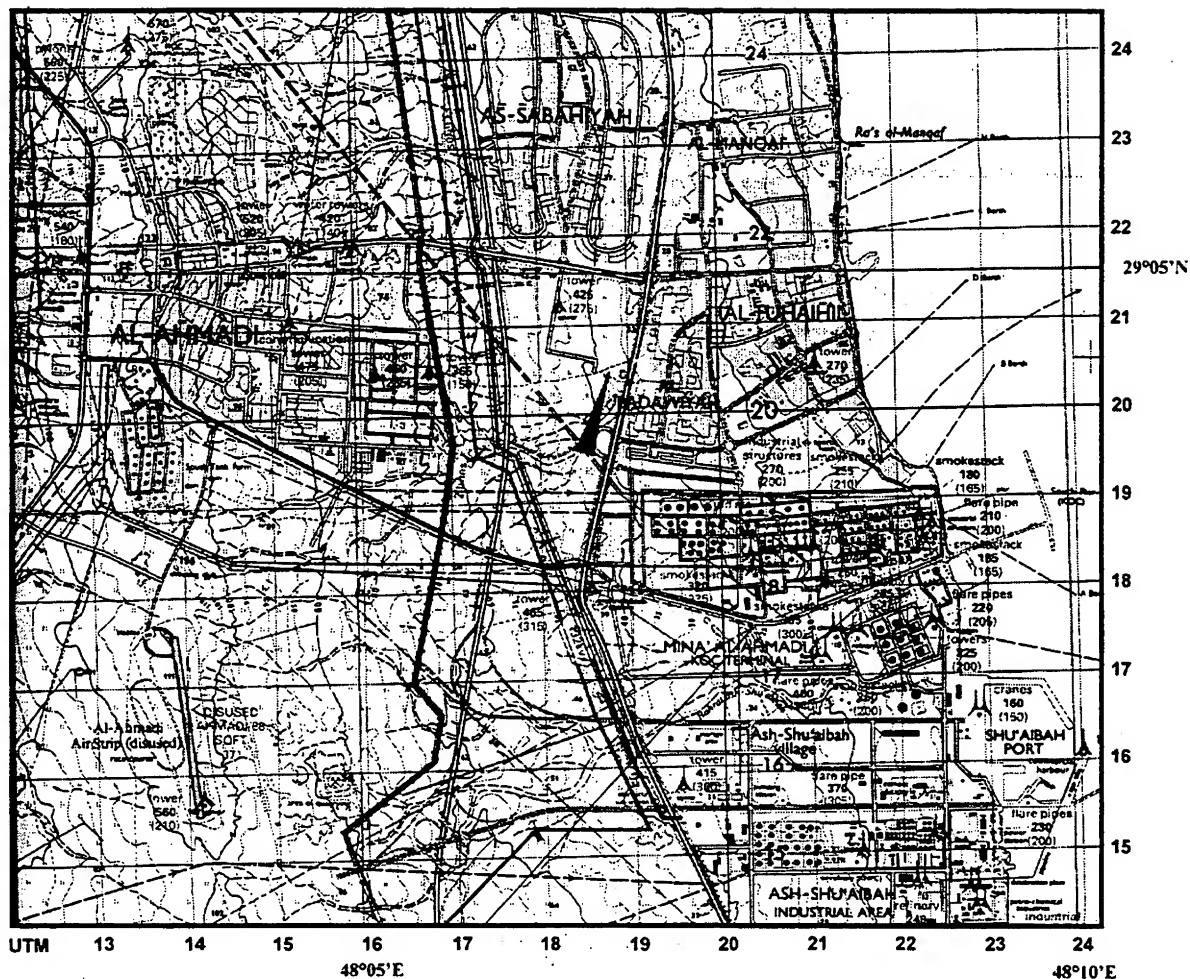


Figure 2. Map of the Al Ahmadi district.<sup>1</sup> Red arrow indicates location of the Kuwaiti Girls' School.

In early March 1991, coalition forces in the Kuwaiti theater of operations explored the Al Badawiyah Girls Sciences School in the Al Badawiyah suburb of Kuwait City at coordinates 2904N4806E (UTM Grid 18832039).<sup>2</sup> (Figure 2) During our investigation we found that the Al Badawiyah Girls Sciences School has also been known as the Sabahiyah High School for Girls<sup>3</sup>, the Ansarieh Banat Kebeed School<sup>4</sup>, and the Al Nasser School for Secondary Curriculum. In

<sup>1</sup> Sheet K7611, 5648-III, Al Ahmadi, Edition 5-GSGS, Directorate of Military Survey, Ministry of Defence, UK.

<sup>2</sup> IIR 5380 005 91, 290938Z MAR 91, "SILKWORM Test Facility"

<sup>3</sup> Major Watkinson's Initial Report, August 7, 1991, p. 1.

<sup>4</sup> Letter from Passive Barriers to Brown & Root dated August 24, 1991. Letter from Brown & Root to Contracting Officer, Kuwaiti Emergency Recovery Office dated October 30, 1991.

1991, the school was known as the Ansarieh Banat Kabeed School. The school falls within the Sabahiyah municipality and the Badawiyah district and thus, may also be referred to by locality.<sup>5</sup> (Figure 2) In 1997, however, the school was known as the Al Nasser School for Secondary Curriculum. (Figure 3) UK Parliamentary and US Senate Committee investigators, as well as the media, have routinely referred to the building as the Kuwaiti Girls' School. For purposes of this report, the school will be referred to as the Kuwaiti Girls' School.



Figure 3. Photograph of the front of the school circa October 1997.<sup>6</sup> The sign at the top of the building reads: Al Nasser School for Secondary Curriculum.

### **Iraqi Use of the Kuwaiti Girls' School**

During the Gulf War the Kuwaiti Girls' School was used by the Iraqis as a SILKWORM missile test and maintenance facility. An initial intelligence report of March 29, 1991 from coalition forces who had been present at the Kuwaiti Girls' School, stated six Chinese-made SILKWORM anti-ship missiles were found inside the building. (Figure 4) In addition to these six missiles, the retreating Iraqi forces abandoned much support equipment, such as the missile test carts, cabling and a Chinese-manufactured generator vehicle, discovered inside the school. Two abandoned Soviet missile transport trucks were located next to a truck-mounted crane 100 meters west of the school and a Chinese generator was positioned 600 meters west of the school. The initial intelligence report noted that the auditorium appeared to have been used as a troop

<sup>5</sup> Lead Sheet 5987, Interview with US State Department Kuwaiti Desk Officer.

<sup>6</sup> Photograph of the front of the school taken during the Special Assistant for Gulf War Illnesses trip to Kuwait in October 1997.



messing/berthing area. The condition of the area indicated that the Iraqi troops had departed hastily.<sup>7</sup>

Iraqi use of the Kuwaiti Girls' School as a SILKWORM test and maintenance facility was treated as classified. According to written and oral statements, none of the individuals and organizations who would come to be involved with events at the Kuwaiti Girls' School in August, 1991, had any knowledge of what purpose, if any, the Iraqis had used the school. To date, none of the coalition forces present at the Kuwaiti Girls' School on March 29, 1991, have been located for interviews. Efforts to contact them continue.

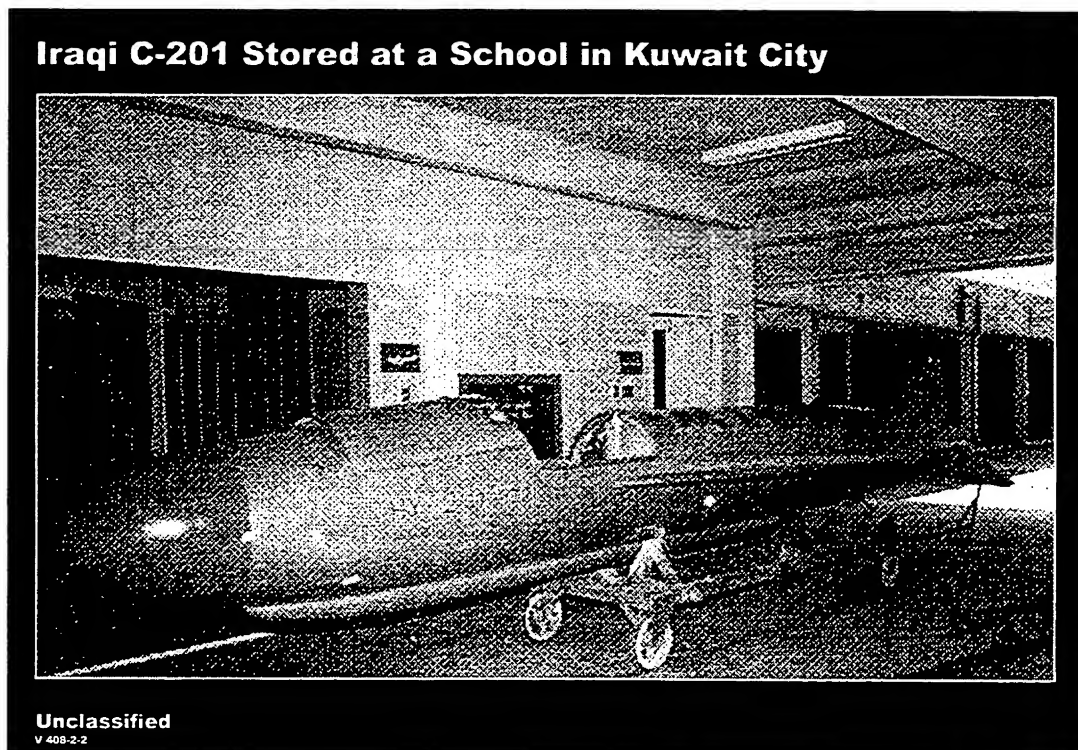


Figure 4. Captured Iraqi SILKWORM anti-ship missile at the Kuwait Girls' School.

The detailed report of March 29, 1991, made no reference to any missile fuel or oxidizer storage tank located in or around the school. However, photography from March 1, 1991, clearly shows that the tank was present at the time. (Figure 5) As a test and maintenance facility, the presence of a storage container for the highly volatile oxidizer used in these missiles would be expected. The SILKWORM anti-ship missile uses Inhibited Red Fuming Nitric Acid (IRFNA) as its oxidizer.<sup>8</sup> According to the Chemical Propulsion Information Agency, IRFNA is a highly corrosive oxidizing agent, light-orange to orange-red in color, transparent, strongly fuming and

<sup>7</sup> IIR 5380 005 91, 290938Z MAR 91, "SILKWORM Test Facility"

<sup>8</sup> "The ongoing saga of the 'Styx'", *Jane's Intelligence Review*, July 1, 1997, p 304.

unstable. It will react with many organic materials, resulting in spontaneous combustion.<sup>9</sup> (TAB D)

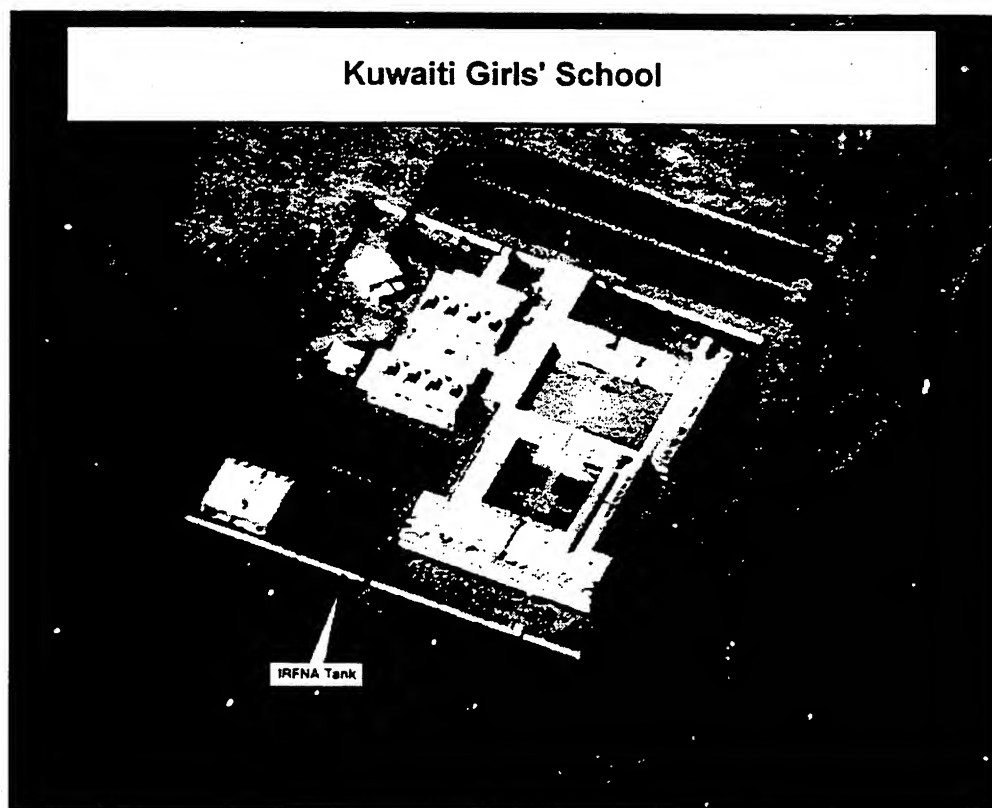


Figure 5. U2 reconnaissance photo of the Kuwaiti Girls' School from March 1, 1991.<sup>10</sup> The obstructed view is due to oil well fire smoke over the area.

Prior to Operation Desert Storm, the United States' Defense Intelligence Agency assessed that Iraq was "likely to have a CW [chemical warfare] warhead for its SILKWORMs."<sup>11</sup> Examination of captured Iraqi SILKWORM warheads indicated that they were only high-explosive in nature. (Figure 6) A US report on captured Iraqi military hardware dated September 12, 1991, stated that thirty SILKWORM warheads would be available for evaluation and other use upon their arrival in the continental United States in September/October 1991.<sup>12</sup> A subsequent report dated October 29, 1991, stated that the New Mexico Institute of Mining and Technology, Terra Group, was to receive nineteen warheads; nine were to go to the Naval Warfare Center, China Lake, California; and the remaining two would go to the Naval Explosive

<sup>9</sup> Hazards of Chemical Rockets and Propellants, Vol III Liquid Propellants, Chemical Propulsion Information Agency, September 1984, pp. 15-1 - 15-16.

<sup>10</sup> U2 reconnaissance photo of the Kuwaiti Girls' School, National Imagery and Mapping Agency, March 1, 1991.

<sup>11</sup> RII-1488, "Mating Chem Warheads to Frogs/SILKWORMs" (CENTAF RFI#803)

<sup>12</sup> 121910Z SEP 91, "Captive Foreign Hardware from Desert Storm".

Ordnance Disposal Technical Center at Indian Head, Maryland.<sup>13</sup> According to the Head of Security for the New Mexico Institute of Mining and Technology, the paperwork for all nineteen warheads indicated they were all high-explosive.<sup>14</sup> A representative from the Naval Warfare Center, China Lake, California, indicated that all warheads received were destroyed as high-explosive warheads.<sup>15</sup> Likewise, a representative from the Naval Explosive Ordnance Disposal Technical Center at Indian Head, Maryland, stated that both SILKWORM warheads received were definitely high-explosive in nature. He indicated that he "had heard of no CW [chemical weapons] warheads for Iraqi SILKWORMs," noting that if they did exist, they would definitely have been evaluated.<sup>16</sup>

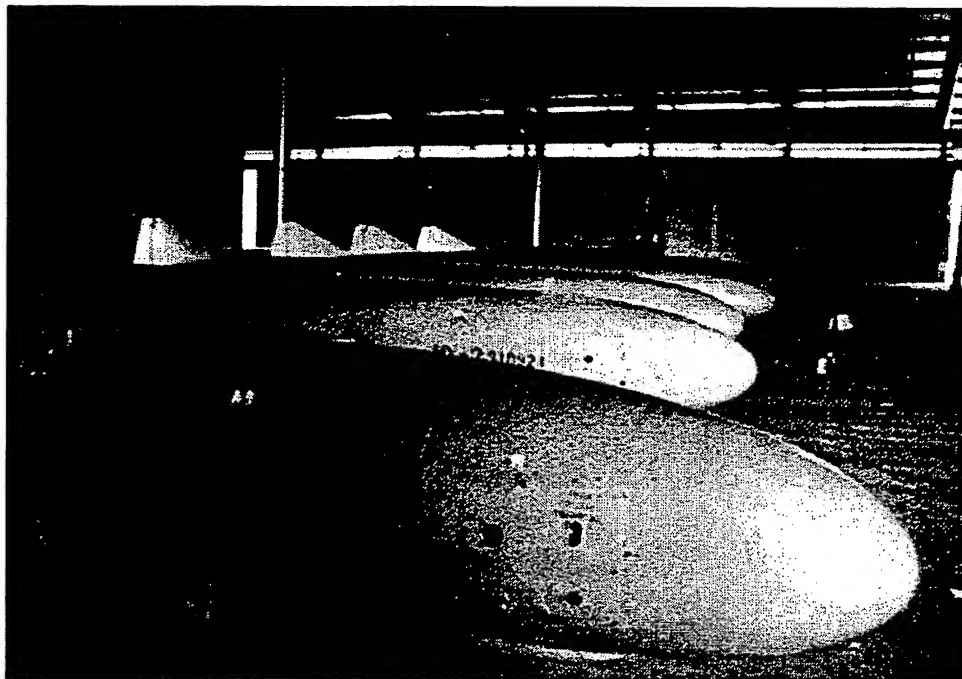


Figure 6. Photograph of six SILKWORM missiles captured at the Kuwaiti Girls School awaiting transport to the US.<sup>17</sup> Note the serial number on the first missile above, matches that of the missile at the Girls' School in Figure 4.

### Reconstruction of Post War Kuwait

Following the expulsion of Iraqi forces from Kuwait, the Government of Kuwait set about the reconstruction of the infrastructure damaged during the Iraqi occupation. The US Army Corps of

<sup>13</sup> 291338Z OCT 91, "Distribution of Explosive Components from Desert Storm Captive Hardware".

<sup>14</sup> Memorandum for record regarding SILKWORM warheads, OSAGWI, October 21, 1997.

<sup>15</sup> Memorandum for record regarding SILKWORM warheads, OSAGWI, October 21, 1997.

<sup>16</sup> Memorandum for record regarding SILKWORM warheads, OSAGWI, October 21, 1997.

<sup>17</sup> Photograph of SILKWORM missiles captured at the Kuwaiti Girls School awaiting transport at the Shubaiha Port, Kuwait to the US for exploitation. Photo taken by US Naval officer, March 1991.

Engineers established the Defense Reconstruction Assistance Office (DRAO) and the Kuwaiti Emergency Recovery Office (KERO) to direct the majority of these operations. Efforts to clear unexploded ordnance ran in tandem with efforts to carry out physical repair to essential infrastructure. The Government of Kuwait issued its own contracts to clear unexploded ordnance (called Explosive Ordnance Disposal, or EOD) within Kuwait. It divided the country into six large sectors and spread the work among the coalition forces, specifically the UK, US, France, Egypt, Bangladesh and Pakistan.<sup>18</sup> A weekly meeting was established to assess clearance progress and allocate new tasks.

Each country involved approached the EOD task slightly differently. Egypt, Bangladesh, and Pakistan used their own EOD trained soldiers. France and the US planned to use contractors. The UK used a British contractor called Royal Ordnance who in turn hired trained British soldiers from the UK MOD to clear its sector.<sup>19</sup> However, it should be noted that the sectors delineated for ordnance clearing did not correspond to those delineated for reconstruction efforts.

### **Discovery of the Suspicious Storage Tank at the Kuwaiti Girls School: First Week of August 1991**

The schools in Kuwait were the main focus of civil infrastructure repair. The schools had been closed for nearly a year and their reopening was considered an important indicator of a return to normality within the country.

In early August 1991, a British explosive ordnance disposal (EOD) firm known as Passive Barriers subcontracted by Brown & Root, an American firm carrying out reconstruction tasks on schools in Kuwait, discovered a suspicious metal storage tank alongside the perimeter wall of the Kuwaiti Girls' School.<sup>20</sup> Both Passive Barriers and Brown & Root were unaware that in March this site was explored by coalition forces and that Iraqi military equipment, including the SILKWORM missiles, was taken away. According to the Brown & Root supervisor, the protocol for the reconstruction effort called for Passive Barriers to clear the area before Brown & Root commenced work. While clearing the area, Passive Barriers personnel discovered the tank and notified Brown & Root, which contacted KERO. The KERO safety officer was dispatched to inspect the tank.<sup>21</sup>

When interviewed, the safety officer stated that fumes were escaping from the tank through two holes, which had been caused by a single bullet. The bullet had broken in half on entry and was stuck in the exit hole. The safety officer stated that the rust colored vapors puffing from the bullet holes in the tank smelled like acid. Based on the color of the fumes and their smell, he determined the contents to be nitric acid. Pinging the tank to check the fill level, he estimated

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<sup>18</sup> Dr. Janet McDonnell, (Draft) After Desert Storm, The US Army and the Reconstruction of Kuwait, Office of History, US Army Corps of Engineers, October 1997, p. 97.

<sup>19</sup> Dr. Janet McDonnell, (Draft) After Desert Storm, The US Army and the Reconstruction of Kuwait, Office of History, US Army Corps of Engineers, October 1997, p. 97.

<sup>20</sup> Lead Sheet 5981, Interview with program manager for Brown & Root Kuwaiti school reconstruction effort, p. 1.

<sup>21</sup> Lead Sheet 7213, Interview with US Army Corps of Engineers safety officer, p. 2.

that it was about one-third full. Despite not wearing protective gear and being close enough to identify the smell of the vapor, the safety officer exhibited no symptoms corresponding to chemical weapons exposure.<sup>22</sup> All subsequent contact with the vapor from the tank was by individuals who were wearing nuclear, biological and chemical (NBC) Individual Protective Equipment (IPE) including respirators, and thus were not able to identify the smell of the vapor.

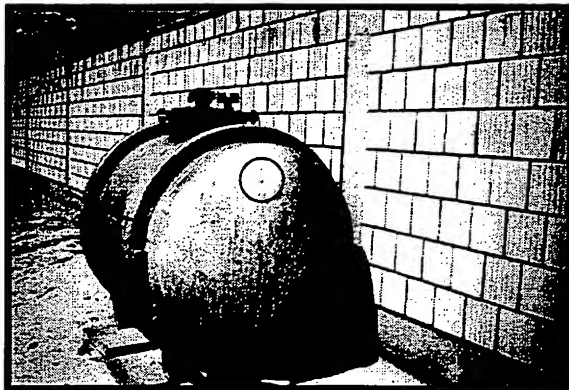


Figure 7.

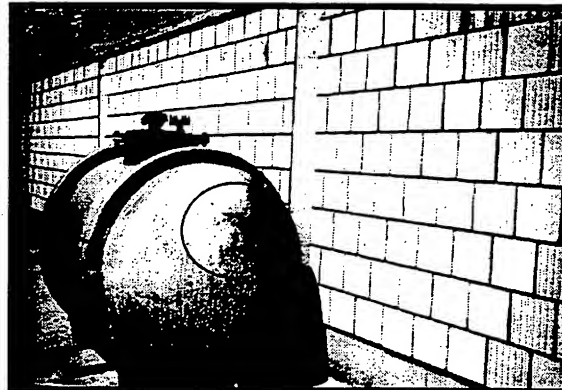


Figure 8.

Photographs of the storage tank at the Kuwaiti Girls' School taken by the safety officer.<sup>23</sup> Encircled areas show the movement of the fumes out of the bullet hole.

The safety officer took several pictures of the area, including two of the tank. These photographs were handed over to the DRAO operations officer. (Figures 7 and 8). The safety officer informed the operations officer that, based on the smell and color of the fumes, he believed the tank contained nitric acid. The safety officer never documented his inspection of the tank.<sup>24</sup> According to a military policeman<sup>25</sup> involved in DRAO's weekly situation reports, the storage tank was thought to contain fuel, however, not wanting to take any unnecessary risks, the operations officer ordered the contents to be tested.<sup>26</sup> According to Major General Patrick Kelly who was in command of DRAO, they contacted someone in Saudi Arabia to inspect the tank and asked the Kuwaiti Army Chief of Staff to secure the area.<sup>27</sup> Rather than pass his assessment on to those testing the tank, the safety officer was instructed to deal with the DRAO's operations officer.<sup>28</sup>

DRAO informed Colonel John Macel, who was the US Army Liaison Officer Kuwait, about the tank. Colonel Macel indicated that he visited the site and sealed off the area, pending a determination of a course of action. Military police from DRAO and personnel from Task Force

<sup>22</sup> Lead Sheet 7213, Interview with US Army Corps of Engineers safety officer, p. 1.

<sup>23</sup> Photographs of the storage tank at the Kuwaiti Girls' School taken by the safety officer, August 1991.

<sup>24</sup> Lead Sheet 7213, Interview with US Army Corps of Engineers safety officer, p. 2

<sup>25</sup> Lead Sheet 5984, Interview with Defense Reconstruction Assistance Office military policeman, p. 1.

<sup>26</sup> All of the Defense Reconstruction Assistance Office's situation reports and logs from July through October 1991 were reviewed, however, no mention of the storage tank at the Kuwaiti Girls' School could be found. Lead Sheet 5988, Interview with US Army Corps of Engineers historian, p. 1.

<sup>27</sup> Lead Sheet 7005, Interview with Major General Kelly, USA (Ret.), p. 1.

<sup>28</sup> Lead Sheet 7213, Interview with US Army Corps of Engineers safety officer, p. 2

Victory were summoned to seal off the area.<sup>29</sup> However, the area was not sealed nor were any US or Kuwaiti military personnel present when Major Watkinson, the commanding officer of 21<sup>st</sup> EOD Squadron, British Royal Engineers, conducted his initial reconnaissance and testing of the tank (see below).

### **Nature of Operations at the Tank at Kuwaiti Girls' School in August 1991**

Concern over the contents of the tank coupled with the overlap in jurisdiction at the national and organizational level resulted in four separate operations being conducted at the tank: 1) Major Watkinson's testing, 2) the Fox vehicle testing, 3) sampling of the tank, and 4) permanent sealing of the tank. These operations were not necessarily conducted by the same individuals and these individuals were not always aware of the other operations. This meant that some individuals ended their involvement with limited information and unanswered questions about the nature of the tank's contents. For a brief listing of the major individuals and organizations involved in the testing of the tank's contents see TAB E. For graphical representations of the involvement of the key individuals and organizations, see TABs F and G.

### **Testing of the Tank's Contents - Initial Activity**

As stated above, post-war efforts to clear unexploded ordnance were conducted simultaneously with efforts to carry out physical repairs to essential infrastructure in Kuwaiti. However, the sectors delineated for ordnance clearing did not correspond to the boundaries used for reconstruction efforts. Thus, the school, while in the US sector for reconstruction, was in the British sector for ordnance clearing.

Major Watkinson first became aware of the tank at the Kuwaiti Girls' School on the morning of August 5, 1991 during one of the regular meetings held between the Kuwaiti MOD and various EOD agencies involved in the reconstruction of Kuwait. Kuwaiti military officers specifically tasked a British company, Royal Ordnance, to investigate the tank. 21<sup>st</sup> EOD Squadron was one of the British military units on loan to this company to conduct EOD operations. As Major Watkinson was present at the meeting, the task was immediately referred to him.

Regarding the British EOD tasking, Major Watkinson stated:

"I attended a meeting on the 5th of August [1991] with the Kuwaiti Ministry of Defense which was a regular meeting, between Kuwaiti Army Officers and various agencies in Kuwait, who were involved in EOD operations. It was at that meeting that I first became aware of the container, because one of the Kuwaiti officers specifically asked Royal Ordnance if they could investigate it. A member of the Royal Ordnance Management Team was at that meeting and they immediately referred the problem to me, to investigate, which I subsequently did. Royal Ordnance was a UK firm which effectively

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<sup>29</sup> Transcript of Interview with Colonel Macel, October 16, 1997, p. 7.

subcontracted [with] the UK Ministry of Defence to have British military forces in theater assist with the clearance."<sup>30</sup>

The commanding officer of the US 146<sup>th</sup> EOD Detachment indicated that he was first informed about the tank by a Brigadier General in Riyadh, Saudi Arabia.<sup>31</sup> At the same time, the senior EOD officer in theater was ordered by Major General Kelly from the Defense Reconstruction Assistance Office to examine the tank.<sup>32</sup> The senior EOD officer directed the commander of the 146<sup>th</sup> EOD detachment to examine the tank and search the site for additional tanks and other suspicious items.<sup>33</sup>

According to the commander of the 146<sup>th</sup> EOD detachment, on August 5, 1991, he and Major Watkinson, who was the commanding officer of 21<sup>st</sup> EOD Squadron, British Royal Engineers, examined the tank.<sup>34</sup> However, Major Watkinson has no recollection of any US personnel being present during the first operation, nor is their presence recorded in his post-operation report.

### **The First Operation - The Initial Testing of the Tank's Contents**

After some initial confusion in locating the school, Major Watkinson accompanied by his bomb disposal engineer found a metal storage tank with a capacity of approximately 2000 liters outside the perimeter walls of the Kuwaiti Girls' School.<sup>35</sup> The school was not in use, but the school security officer was present. Also in the area was a British EOD subcontractor employed by an American firm to clear explosive ordnance and rubbish.

Wearing full IPE, which consisted of the British Mk IV NBC suit and S10 respirator, Major Watkinson approached the tank. Following standard practice, where minimum numbers of personnel necessary go forward, the bomb disposal engineer remained at a safe distance in radio contact. Major Watkinson then tested the tank with a chemical agent monitor (CAM) (Figure 9), British one-color detector paper (Figure 10), and an M18A2 kit (Figure 11).<sup>36</sup> A chemical agent monitor is a portable, hand-held instrument used to monitor the presence of nerve or blister agents. It operates by drawing air into the unit, which is ionized by a weak radioactive source. The level of toxic hazard is assessed by an on-board micro computer and indicated by a liquid crystal display.<sup>37</sup> The M18A2 kit is a portable, expendable item capable of surface and vapor analyses. The presence of chemical agent is indicated by distinctive color changes.<sup>38</sup>

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<sup>30</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 1.

<sup>31</sup> Lead Sheet 6025, Interview with commander of the 146<sup>th</sup> EOD Detachment, p. 1

<sup>32</sup> Lead Sheet 6430, Interview with senior EOD officer in theater, p. 1.

<sup>33</sup> Lead Sheet 6430, Interview with senior EOD officer in theater, p. 1.

<sup>34</sup> Lead Sheet 6025, Interview with commander of the 146<sup>th</sup> EOD Detachment, p. 1.

<sup>35</sup> Major Watkinson's Initial Report, August 7, 1991, p. 1.

<sup>36</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 8.

<sup>37</sup> Worldwide Chemical Detection Equipment Handbook, Chemical and Biological Defense Information Analysis Center, Aberdeen Proving Ground, MD, October 1995, p. 332. Copies of the Worldwide Chemical Detection Equipment Handbook may be purchased from the CBIAC. To order, please contact Ms. Shetterly, CBIAC Administrator, 410-676-9030.

<sup>38</sup> Worldwide Chemical Detection Equipment Handbook, p. 422.



The vapor escaping from the tank through the bullet hole tested positive on the chemical agent monitor, giving a reading of eight bars for mustard agent,<sup>39</sup> which is the highest possible reading. Next, Major Watkinson tested the vapor using one-color detector paper. This gave no response, which was not surprising as the paper is a liquid detector paper and is not designed to react to vapor. Recognizing this, he then conducted a further test using liquid extracted from the tank by dipping a piece of wire into the tank through one of the bullet holes. He wiped the wire on the one-color detector paper, which caused it to turn brown. This is a negative result for UK one-color detector paper, which turns blue in the presence of chemical warfare agent. He then wiped some of the tank's contents on to the US three-color detector paper from the M18A2 kit.<sup>40</sup> The three-color paper, however, turned pink, which Major Watkinson took to indicate that chemical warfare agent might be present.<sup>41</sup> Three-color paper is designed to turn red in the presence of blister agent (it turns yellow in the presence of G-series nerve agent, and green in the presence of V-series nerve agent).



Figure 9 Chemical Agent Monitor<sup>42</sup>



Figure 10 British one-color detector paper<sup>43</sup>

Major Watkinson followed up the CAM and detector papers tests with an M18A2 kit. Regarding that test, he stated:

<sup>39</sup> According to the US Army, mustard agent is an oily liquid that ranges in color from a light yellow to brown and its odor is that of garlic, onion, or mustard (hence its name). Sublethal doses of mustard agent causes redness and blisters on the skin, irritation and damage to the eyes, and mild upper respiratory distress to marked airway damage. The clinical effects of mustard are not immediate, taking as little as two hours after a high-dose exposure, and as long as 24 hours following a low-dose vapor exposure. Field Manual 3-9, Potential Military Chemical/Biological Agents and Compounds, Blister Agents (Vesicants): Mustard (HD, H).

<sup>40</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 13.

<sup>41</sup> Major Watkinson's Initial Report, August 7, 1991, pp. 1-2.

<sup>42</sup> Photograph of Chemical Agent Monitor (CAM), UK Ministry of Defence.

<sup>43</sup> Photograph of British one-color detector paper, UK Ministry of Defence.



"The M18A2 kit has glass tubes that contain, sort of the cotton wool type substance, which is impregnated with certain chemicals. Obviously there are a whole series of different tubes which are designed to detect for different agents. One can go through those tubes in sequence, in order to eliminate various chemicals and decide what it is you've got. I didn't go through that process fully, because I'd got a reading with the CAM [chemical agent monitor] and therefore I narrowed straight in on the H [mustard] agent."<sup>44</sup>

Major Watkinson tested the vapor six times with the M18A2 kit by sucking the vapor through glass tubes using a rubber bulb. Major Watkinson stated that to test positive for mustard agent, the tube would have to turn blue: as some of them did not he ended up testing it six times.<sup>45</sup> Four of the tubes turned blue, indicating mustard agent. The remaining two tubes turned yellow but turned blue some hours later.<sup>46</sup>

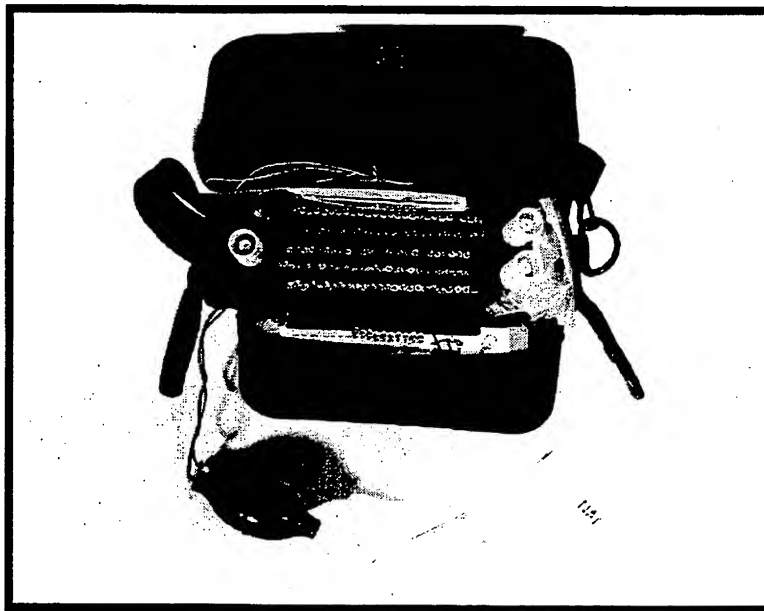


Figure 11 M18A2 chemical agent detector kit<sup>47</sup>

Major Watkinson, like all others involved in the August 1991 testing of the tank, was unaware the school had been used as a SILKWORM facility, and thus that the tank may have contained IRFNA. Additionally Major Watkinson, like all others involved in the testing, was unaware that IRFNA would cause the CAM to register a false positive for blister agent. A US Army message dated February 19, 1991, indicated "fuming nitric acid will drive the CAM [chemical agent monitor] to 8 bars on the mustard scale."<sup>48</sup> This message was based on experience using CAMs with residual IRFNA from a SCUD that impacted at Hafir Al Batin. The US Army VII Corps

<sup>44</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 14.

<sup>45</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 14.

<sup>46</sup> Major Watkinson's Initial Report, August 7, 1991, pp. 1-2.

<sup>47</sup> Photograph of M18A2 chemical agent detector kit, UK Ministry of Defence.

<sup>48</sup> Email Message from VII Corps RBBS to all MSC's, CAM Burnout, 191741 FEB 91.

chemical officer forwarded this information to all units via e-mail and recommended using the M256 kit if the CAM gives a positive reading of 8 bars on mustard agent.<sup>49</sup> Neither Major Watkinson nor any other units involved in testing the tank at the Kuwaiti Girls' School was ever informed of this message. It is important to note the message was disseminated in February 1991, but Major Watkinson and 21<sup>st</sup> EOD Squadron did not arrive in theater until May 1991. Likewise, none of the US units that would subsequently become involved in the testing of the tank were in theater in February 1991, nor were any informed of the message.

During the testing, Major Watkinson inadvertently came into contact with the tank's contents. He stated,

"There was some of the liquid on the wire, which I then wiped onto the detector paper. I can only assume that in the process of doing that, I got some of the liquid onto the back of my thigh, and it went through [penetrated] my suit."<sup>50</sup> (Figure 12) "It wasn't something that I was immediately aware of. In fact, it wasn't until I got back to the camp that evening that I noticed I'd been burnt. But it wasn't particularly painful, it was more a question of being uncomfortable."

He noted that it was just a red mark approximately 4 cm x 2.5 cm<sup>51</sup>, and did not blister at all.<sup>52</sup> He sought medical attention for the injury on August 9, 1991, four days after he sustained the injury. According to the medical report, the burn did not blister but was slightly raised and very red. It responded well to treatment with sulphadiazine cream<sup>53</sup> and had completely healed within seven to 10 days.<sup>54</sup>

Major Watkinson further noted:

"The significance of the injury is...relevant, because I was dressed in all the full NBC (Nuclear, Biological & Chemical) protective equipment, and I at the time couldn't understand how I managed to get burned on a part of my body where there was no joint in the NBC clothing. The implication was that the chemical had gone through the NBC suit. This was a bit of a concern, because obviously our NBC suit was designed to protect us and clearly on this occasion it hadn't."<sup>55</sup>

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<sup>49</sup> Email Message from VII Corps RBBS to all MSC's, CAM Burnout; 191741 FEB 91.

<sup>50</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 13.

<sup>51</sup> Major Watkinson's Subsequent Report, August 18, 1991, E-1.

<sup>52</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 11.

<sup>53</sup> Major Watkinson's Subsequent Report, August 18, 1991, E-1.

<sup>54</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 11.

<sup>55</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 11.



Figure 12 British NBC suit<sup>56</sup>

Major Watkinson concluded the operation by sealing both bullet holes using an industrial silicone filler and plaster of paris bandages. He checked the tank for leaks with a chemical agent monitor; none were found.<sup>57</sup>

According to Major Watkinson's report dated August 7, 1991, the security officer employed at the school prior to the conflict, first noticed the container on March 20, 1991. At that time, the security officer believed the container to be leaking.<sup>58</sup>

Additionally, Major Watkinson stated that Kuwaiti Police reportedly attempted to take some samples to the Kuwait Oil Company for testing.<sup>59 60</sup> He went on to describe efforts to confirm or deny this information stating:

"One of the considerations early on was to try and establish whether there were any results from the Kuwaiti Oil Company, because we weren't sure what the chemical contents of the tank were. Although some inquiries were made along those directions, they didn't come to anything. Things need to perhaps be put in perspective. Kuwait, in the aftermath of the war, was in a state of disorganization... So, we didn't really pursue it to any great extent."<sup>61</sup>

Efforts to confirm or deny whether the Kuwaiti Oil Company or any other Kuwaiti organization obtained and analyzed samples of the material in the tank continue.

### The First Operation - Conclusions of the Initial Testing

Despite conducting several tests using a CAM, M18A2 kit, and one- and three-color detector paper it was not possible positively to identify the substance in the tank. The CAM had indicated the presence of mustard agent, but the one-color detector paper gave a negative response. Although the three-color detector paper and the M18A2 kit had given a possible indication of mustard agent, the results were not conclusive.

Based on these results, Major Watkinson concluded that the tank probably contained mustard agent. His post-operation report recommended that a discrete guard of the tank should be mounted until the samples which the Kuwaiti Oil Company had apparently taken could be analyzed and the tank and its contents destroyed. It appears that following Major Watkinson's

<sup>56</sup> Photograph of British NBC protective gear, UK Ministry of Defence.

<sup>57</sup> Major Watkinson's Initial Report, August 7, 1991, pp. 1-2.

<sup>58</sup> Major Watkinson's Initial Report, August 7, 1991, pp. 2-3.

<sup>59</sup> Major Watkinson's Initial Report, August 7, 1991, p. 2.

<sup>60</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 4.

<sup>61</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 6.

initial tests and his recommendation that the area should be secured, Colonel Macel called in military police from DRAO and personnel from Task Force Victory to seal off the area.

In his interview, Major Watkinson recently summarized the initial testing as follows:

"As far as I'm concerned, the CAM [chemical agent monitor] test was positive. It was eight bars on H [mustard]. Both the one-color and three-color detector paper changed color, but the colors weren't entirely appropriate with the color that I would have expected. So, that was a positive result, but with question marks. The M18A2 detector kit gave a test which again could've been interpreted as positive, but wasn't as conclusive as one would hope."<sup>62</sup>

### **The First Operation - Subsequent Activity**

Based on the results of Major Watkinson's initial tests, a meeting was held on August 6, 1991, to determine an appropriate course of action. Those in attendance included Kuwaiti military personnel, British personnel including Major Watkinson, Colonel Macel and the Chief of Staff for Task Force Victory, Lieutenant Colonel Donnie Killgore.<sup>63</sup>

The initial proposal recommended removing the container from the city and destroying it in the desert.<sup>64</sup> This, however, was deemed premature. Major Watkinson was aware that a UN Chemical Weapons Evaluation Team was in Iraq attempting to determine the Iraqi chemical posture and the container could have been useful to the team's efforts. In particular, if the container did contain chemical warfare agent it would clearly demonstrate Iraqi forward deployment of bulk chemical warfare agent. It was therefore decided that a UN team should be invited to take samples from the tank. Headquarters British Forces Kuwait agreed to make the arrangements.<sup>65</sup> This prompted Lieutenant Colonel Killgore to suggest using Fox nuclear, biological and chemical reconnaissance vehicles assigned to the 11<sup>th</sup> Armored Cavalry Regiment to confirm or deny the presence of chemical warfare agent in the container.<sup>66</sup>

While the chemical agent monitor and many other chemical detection kits available to military forces can positively identify only a few chemical warfare agents or groups of agents, such as blister and nerve agents, the Fox reconnaissance vehicle can identify 60 known chemical agents using a computerized mobile mass spectrometer.<sup>67</sup> This device is helpful in identifying the

<sup>62</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 14.

<sup>63</sup> Memorandum for the Office of the Assistant Secretary of Defense for Chemical Biological Matters [OASD (CBM)], Suspect Chemical Container Found in Kuwait City, Kuwait in August 1991, July 29, 1994, p. 5.

<sup>64</sup> Memorandum for the Office of the Assistant Secretary of Defense for Chemical Biological Matters [OASD (CBM)], Suspect Chemical Container Found in Kuwait City, Kuwait in August 1991, July 29, 1994, p. 5.

<sup>65</sup> GVIU investigators' telephone conversations with the Sampling Team Leader and Major Watkinson, March 5, 1998.

<sup>66</sup> Memorandum for the Office of the Assistant Secretary of Defense for Chemical Biological Matters [OASD (CBM)], Suspect Chemical Container Found in Kuwait City, Kuwait in August 1991, July 29, 1994, pp. 4-5.

<sup>67</sup> For a detailed explanation of the Fox NBC reconnaissance vehicle see, Fox Information Paper, Office of the Special Assistant for Gulf War Illnesses, July 29, 1997.

individual component chemical compounds by providing the molecular composition and weight of ions of those compounds. The use of the Fox vehicles was approved and on August 7, 1991, the 54<sup>th</sup> Chemical troop received a tasking memorandum from Headquarters, Task Force Victory, directing them to support 21<sup>st</sup> EOD Squadron, British Royal Engineers during the second operation to conduct tests on the tank's contents.<sup>68</sup>

In his report, the Commander of the 54<sup>th</sup> Chemical Troop, then Captain Michael Johnson, noted that, upon receipt of the tasking, the troop leadership went to the US Embassy in Kuwait and received a complete mission brief by Colonel Macel. Additionally, the troop leadership briefed Colonel Macel on the capabilities of the Fox vehicle and how the troop would conduct the mission.<sup>69</sup> The operation was to be the first live joint detection operation between American and British forces. As such, rehearsals were staged to ensure that differences in tactics, doctrine, and other areas were properly addressed.<sup>70</sup> It was determined that Major Watkinson, who had originally tested the tank, would be the Commanding Officer for the second operation, while Captain Johnson would direct the Fox operations.<sup>71</sup>

According to the commander of the 146<sup>th</sup> EOD Detachment, a few days after the initial testing of the tank, he obtained information which called into question the suggestion, based on Major Watkinson's test results, that the tank might contain mustard agent.<sup>72</sup> The commander of the 146<sup>th</sup> stated that an Egyptian EOD officer identified a picture of the tank as being that of a Soviet rocket fuel container. According to the commander, the Egyptian EOD officer was reportedly Soviet-trained in rocketry prior to EOD training. The Egyptian EOD officer was killed by a mine shortly after making this assessment and no record of this assessment could be located.<sup>73</sup> Major Watkinson stated that he was not aware of this assessment.<sup>74</sup>

During another meeting of the Kuwaiti MOD and EOD agencies at which Major Watkinson was not present, the suggestion that the tank did not contain chemical warfare agent, but rather a highly-reactive industrial chemical was apparently discussed.<sup>75</sup> This was based on the Egyptian officer's assessment of the container, the ability of the material to penetrate Major Watkinson's protective clothing, and the nature of the subsequent injury. The commander of the 146<sup>th</sup> EOD Detachment did not know why this assessment was not passed on to units tasked to test the tank. Likewise, there was no confirmation that anyone received the US EOD incident report that the senior US EOD officer in theater claims was furnished to Colonel Macel at the Embassy.<sup>76</sup> According to the senior US EOD officer in theater, upon reporting the findings to Colonel Macel, he was informed that the matter was deemed classified. Colonel Macel, however, reports he

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<sup>68</sup> Memorandum for Director, CATD, Iraqi Chemical Agents - Information Paper, January 4, 1994, p. 1., Memorandum for Commander, 11<sup>th</sup> ACR, ATTN: RS3, Tasking Number 91-047, August 7, 1991.

<sup>69</sup> Memorandum for Director, CATD, Iraqi Chemical Agents - Information Paper, January 4, 1994, p. 1.

<sup>70</sup> Memorandum for Director, CATD, Iraqi Chemical Agents - Information Paper, January 4, 1994, p. 1.

<sup>71</sup> Transcript of Interview with Major Watkinson, October 16, 1997, pp. 27-28.

<sup>72</sup> Lead Sheet 6025, Interview with commander of the 146<sup>th</sup> EOD Detachment, p. 2.

<sup>73</sup> Lead Sheet 6025, Interview with commander of the 146<sup>th</sup> EOD Detachment, p. 3.

<sup>74</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 51.

<sup>75</sup> Lead Sheet 6025, Interview with commander of the 146<sup>th</sup> EOD Detachment, p. 3.

<sup>76</sup> Lead Sheet 6430, Interview with senior EOD officer in theater, p. 2.

received no EOD incident report or any other assessment that would indicate the tank did not contain chemical warfare agent.<sup>77</sup> In addition, he stated that the reason for classifying the issue was not based on the nature of the incident. According to Colonel Macel:

"Virtually everything we were sending out of the embassy at that point [was] all classified...that was just sort of how things were being reported particularly ... sensitive Iraqi issues involved. Nothing to do with this particular incident the way it was unfolding, but rather to ensure we protected sensitive information."<sup>78</sup>

Based on interviews with personnel subsequently involved with the tank, it was determined that knowledge of either the contractors' or US Army Corps of Engineers' involvement was limited to Major General Kelly, Colonel Macel, the staff of US Central Command via reporting from Colonel Macel, and the US Country Team at the Embassy in Kuwait. In an interview with Colonel Macel, he pointed out that, given its classified status and the fact that the Corps of Engineers was not charged with handling this type of operation,<sup>79</sup> he did not inform the US EOD officers, Brown & Root, or the US Army Corps of Engineers about any subsequent testing of the tank or the results. The Chief Operations Officer for the DRAO confirmed that, to his knowledge, no one outside of his office was involved in inspecting the tank.<sup>80</sup>

### **The Second Operation - The Fox Vehicle Testing**

On August 9, 1991,<sup>81</sup> US and UK forces converged on the site of the tank. The British forces consisted of the Commanding Officer of the Second Operation, Major Watkinson, and 1 Troop, 21<sup>st</sup> EOD Squadron: a Captain serving as the Bomb Disposal Officer (BDO), a Sergeant serving as the Bomb Disposal Engineer (BDENGR), and other soldiers who, between them, formed the command post and decontamination team. US forces present included Captain Johnson and two Fox crews, a decontamination unit, the 11<sup>th</sup> Armored Cavalry Regimental Chemical Officer, Lieutenant Colonel Killgore, and Colonel Macel. An American Sergeant First Class, assigned to the 54<sup>th</sup> Chemical Troop, directed the Fox vehicle decontamination. He was in full protective equipment along with the BDO, the BDENGR and the two British soldiers who formed the UK decontamination team.<sup>82</sup> (Figure 12) The Fox vehicles, BDO and BDENGR were the only elements beyond the hot line. The hot line separates the area of active operation from the decontamination area. Apart from the soldiers in the decontamination area and those beyond the hot line, all other US and UK forces observed the operation from the safety of the incident

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<sup>77</sup> Transcript of Interview with Colonel Macel, October 16, 1997, p. 5.

<sup>78</sup> Transcript of Interview with Colonel Macel, October 16, 1997, p. 19.

<sup>79</sup> Transcript of Interview with Colonel Macel, October 16, 1997, p. 4.

<sup>80</sup> Lead Sheet 7131, Interview with the operations officer for the Defense Reconstruction Assistance Office.

<sup>81</sup> The exact date remains uncertain. Multiple sources indicate this occurred on August 8, while other reporting indicates it was the 9<sup>th</sup> of August. However, the Fox tapes from the second operation are dated August 9, as well as the sample hand over record commence on August 9 and this notes when the samples were taken, thus we regard the date of August 9, 1991 as being the date of this operation.

<sup>82</sup> Lead Sheet 5982, Interview with US soldier inside the hot line on the day of the Fox testing, p. 1.

command post (ICP), approximately 200 meters N/NE (upwind) and were not in protective suits at the time.<sup>83</sup> (Figure 13)

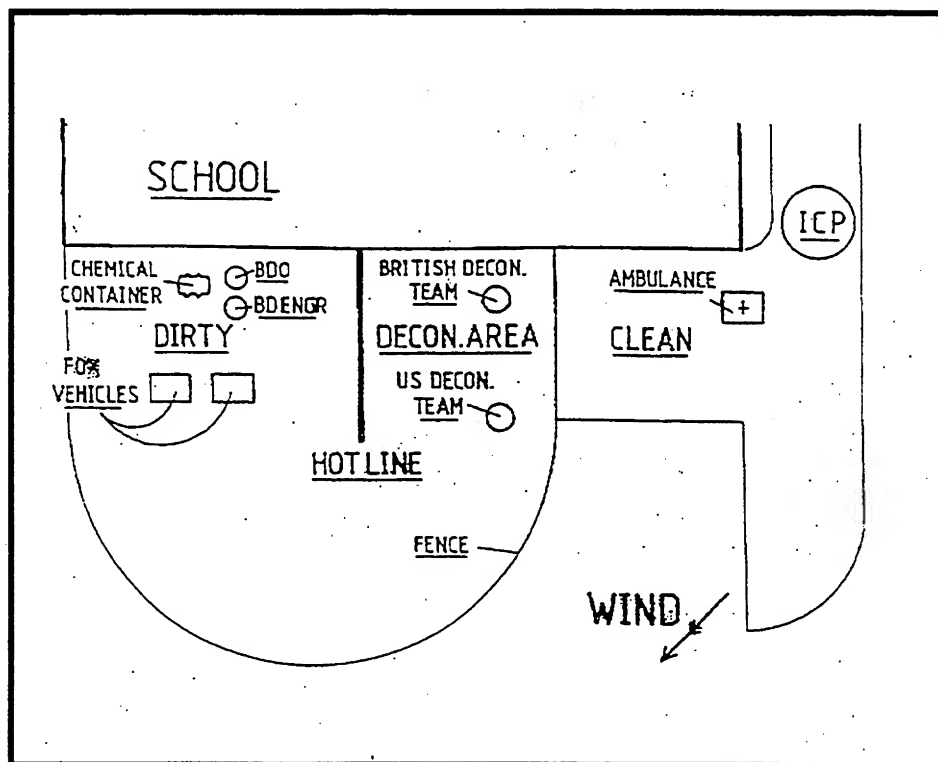


Figure 13. Major Watkinson's sketch of UK and US elements during the Fox testing.<sup>84</sup>

The BDO and the BDENGR unplugged the holes sealed by Major Watkinson during the first operation. On breaking the seals, large quantities of vapor emerged from the tank for approximately two minutes before subsiding to a small vapor emission.<sup>85</sup> This suggested that the vapor pressure inside the tank had increased significantly while it had been sealed.

Using a long piece of rubber catheter tubing, the BDO and the BDENGR took three samples from the tank and placed them in glass vials. Two of the samples were placed into two brown glass bottles which were then placed in a steel ammunition box filled with Fullers Earth.<sup>86</sup> The lid of the ammunition box was closed and left by the tank to be collected later. The third sample was placed in a stainless steel dish for analysis by the Fox vehicles.<sup>87</sup> This sample evaporated

<sup>83</sup> Transcript of Interview with Lieutenant Colonel Killgore, October 15, 1997, p. 8., Major Watkinson's Subsequent Report, August 18, 1991, p. C-1.

<sup>84</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. C-1.

<sup>85</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. 3.

<sup>86</sup> Fullers Earth is a clayish substance of hydrous aluminum silicate. It is a good absorbent, and is used as a filter aid in coagulation.

<sup>87</sup> Statement of Troop Commander of 1<sup>st</sup> Troop, 21 EOD Squadron, November 10, 1997, pp. 2-3.

rapidly, which meant there was insufficient liquid to be tested by the Fox probe. This raised questions concerning the nature of the substance. According to Major Watkinson:

“One of the problems we were having was that the liquid, when put onto a stainless steel kidney tray, was evaporating quite quickly, and we hadn't anticipated this ... mustard gas as I have dealt with it, seen it, and understand it, is fairly viscous, and I wouldn't have expected it to evaporate as quickly as it did. So, in my mind the rapid evaporation of the chemical was another indicator that suggested that this may not be mustard gas.”<sup>88</sup>

The BDO and BDENGR therefore extracted a fourth, larger sample of the liquid and placed it into the stainless steel dish.<sup>89</sup> They presented this sample to each of the Fox probes for analysis. (Figure 14) The Fox vehicles, identified as Vehicle C-23 and Vehicle C-26,<sup>90</sup> had communications between them severed so as not to bias the results.<sup>91</sup> The MM-1 mobile mass spectrometer located on Vehicle C-23 alarmed for phosgene, a choking agent.<sup>92</sup> The Fox team took another sample test to validate the previous identification. The second test also alarmed for phosgene. In accordance with standard operating procedure, the C-23 crew ran full spectrum printouts to confirm the detections.<sup>93</sup> The spectrum run by the MM-1 mobile mass spectrometer onboard the first Fox vehicle was printed to a hard copy tape for later, more detailed analysis. From this point forward, the hard copy tapes generated by the Fox vehicles are referred to as the Fox tapes. (TAB H) With radio communications still cut off, Vehicle C-26 executed the same procedures. The second Fox alarmed for higher levels of phosgene, as well as mustard agent. The C-26 crew, like the first, ran full spectrum printouts to confirm the exact substance present.<sup>94</sup> Fox tapes were also generated by this vehicle's mass spectrometer. (TAB H)

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<sup>88</sup> Transcript of Interview with Major Watkinson, October 16, 1997, pp. 19, 25.

<sup>89</sup> Lead Sheet 5982, Interview with US soldier inside the hot line on the day of the Fox testing, p. 2.

<sup>90</sup> Fox Tapes from testing at the Girls' School.

<sup>91</sup> Lead Sheet 5982, Interview with US soldier inside the hot line on the day of the Fox testing, p. 2.

<sup>92</sup> Lead Sheet 6510, Interview with US officer in charge of decontamination operations on the day of the Fox testing, p. 1., Memorandum for the Office of the Assistant Secretary of Defense for Chemical Biological Matters [OASD (CBM)], Suspect Chemical Container Found in Kuwait City, Kuwait in August 1991, July 29, 1994, p. 6.

<sup>93</sup> Fox Tapes from testing at the Girls' School.

<sup>94</sup> Fox Tapes from testing at the Girls' School.





Figure 14. Photograph of Fox vehicle testing taken by a US Army Lieutenant, 54<sup>th</sup> Chemical Troop.<sup>95</sup>

While the Fox vehicle testing was underway, a fifth sample was taken from the tank in case the Fox vehicle crews required further material to test. This fifth sample was not in fact required and was therefore added to the samples within the two bottles contained in the ammunition box.<sup>96</sup>

During the extraction phase, both the BDO and BDENGR received liquid agent contamination on their hands. They both noticed heat penetrating through their gloves and considered this to be a result of an exothermic chemical reaction between the agent and their rubber NBC gloves. Both operators returned to the decontamination area to change their gloves before continuing with the operation.<sup>97</sup>

According to the BDO taking the samples, after the Fox testing was complete, he and the BDENGR sealed the holes using luting (quick drying putty) and plaster of paris strips.<sup>98</sup> After

<sup>95</sup> Photograph of Fox testing taken by the US officer in charge of decontamination operations.

<sup>96</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. 2.

<sup>97</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. 3.

<sup>98</sup> Statement of Troop Commander of 1 Troop, 21 EOD Sqn, November 10, 1997, p. 3.

the plaster of paris hardened, they used a mixture of super topical bleach and water to decontaminate the tank and the immediate area.<sup>99</sup>

The Fox vehicles were decontaminated and checked using CAMs before moving out of the hot line. The BDO and BDENGR picked up the steel ammunition box containing the samples and their equipment, and returned to the Emergency Personnel Decontamination Station (EPDS). In accordance with standard procedure, the box containing the samples was decontaminated, sealed inside three large clear plastic bags, taped up, and clearly labeled on the outer plastic bag. The BDO and BDENGR moved through the shuffle pit and were undressed by the EPDS Team. They went through full decontamination in the EPDS, including showers and a change of clothing. According to the BDO's statement, all clothes and non-durable equipment used during the operation were destroyed at the EPDS hot line.<sup>100</sup> None of the protective suits used in the operation were saved for analysis; they were all destroyed at the scene.

During the decontamination of the BDO and BDENGR, the Lance Corporal in charge of the EPDS felt a burning sensation on his right wrist. He was decontaminated and his NBC suit and clothing were removed. An on site medical team tended to a 3mm blister which had appeared on his wrist and treated him for heat stress. He was then taken to Beteal Camp where a doctor attended him.<sup>101</sup> This event suggests that a small amount of liquid had been transferred from either the BDO or BDENGR and that this had penetrated the inner glove, suit and outer glove of the Mk IV NBC suit he was wearing.

The BDO stated that, after he had processed through the decontamination line, a British Lance Corporal in charge of the EPDS was injured while conducting the decontamination.

"I was watching the EPDS party finishing the task from the CP (Command Post). At the point when only the [Lance Corporal in charge] IC of the EPDS was left to decontaminate and undress himself he fainted (this I believe was due to the heat and the time spent in [individual protective equipment] IPE). Myself and another went to his assistance pouring vast quantities of water and decontaminant on his bare skin (arm) which was blistering. He was taken to a local ... hospital [21<sup>st</sup> Squadron Medical Center]...."<sup>102</sup>

A report dated January 4, 1994, submitted by Captain Johnson stated that a British team member had come in contact with the liquid. The soldier had an immediate reaction, causing extreme pain and sending him into shock. According to Captain Johnson:

"Within one minute, we observed that the soldier had a small blister forming on his wrist the size of a sticker head. Five minutes later, the blister reached the size of a (US) half-dollar coin."<sup>103</sup>

<sup>99</sup> Statement of Troop Commander of 1 Troop, 21 EOD Sqn, November 10, 1997, p. 3.

<sup>100</sup> Statement of Troop Commander of 1 Troop, 21 EOD Sqn, November 10, 1997, p. 3.

<sup>101</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. 4.

<sup>102</sup> Statement of Troop Commander of 1 Troop, 21 EOD Sqn, November 10, 1997, p. 3.

<sup>103</sup> Memorandum for Director, CATD, Iraqi Chemical Agents - Information Paper, January 4, 1994, p. 2.

None of the American forces present (who have been contacted regarding this matter) can recall being advised of the British soldier's treatment or outcome. Furthermore, the injured British soldier stated that:

"No one came to debrief me about the operation and I was not told about the likely effects of my exposure to the agent in the tank. During my time there [the medical facility] no tests were taken to see if I had been exposed to mustard agent. I was told not to speak to anyone about the incident."<sup>104</sup>

The medical report on the British soldier's injury reads as follows:

"The burn on his wrist was 0.5 x 1.0 cm in diameter (Figure 15), comprising an area of erythema with a centralized pin head erupted zone. This injury is compatible with a variety of chemical or thermal insults ranging from contact with household disinfectants to perhaps more potent corrosive agents. The lesion did not propagate further, and responded quickly to silver sulphadiazine 1% (flamazine). The patient was fully recovered...the following day and was fit to return to duty."<sup>105</sup>

According to the injured soldier, while he was only at the medical facility for one night, he did not return to duty until the following week. In his report, he indicated that, "The scab on my right wrist took some 2 to 3 weeks to heal, but a red mark remained for 3 to 4 months."<sup>106</sup>



Figure 15. Injury sustained by British soldier during Fox testing<sup>107</sup>

<sup>104</sup> Deposition of Injured British Soldier, December 5, 1997, p. 4.

<sup>105</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. E-1.

<sup>106</sup> Deposition of Injured British Soldier, December 5, 1997, p. 4.

## The Second Operation - Conclusions of the Fox Vehicle Testing

At the end of this operation the tank was assessed to contain a chemical agent which tests had indicated as being a mixture of mustard and phosgene agents. Both sets of Fox tapes indicated an alarm for phosgene, not phosgene oxime, and one also indicated mustard. The phosgene alarm was, however, inconsistent with the agent's known characteristics. Phosgene is a choking agent that produces pulmonary edema (fluid in the lungs) in those exposed to it. It is transported as a liquid and has a boiling point of 7.5°C (45.5°F). This means it would be a gas, not a liquid in the desert heat. It has a characteristic odor of sweet, newly mown hay. During World War I, shells filled with vaporized phosgene produced a white cloud which spontaneously converted to a colorless, low-lying gas.<sup>108</sup> The relatively low boiling point of phosgene makes its presence in the tank, which had been fuming for over four months in a desert environment, at temperatures up to 50°C implausible. Furthermore, phosgene's characteristics did not match the odor and color of the substance in the tank. Likewise, the injury sustained by Major Watkinson was in no way similar to that of a pulmonary agent. Finally, Iraq was not known to have phosgene in its chemical weapons inventory.<sup>109</sup>

As neither mustard nor phosgene would have produced immediate symptoms as this had upon contact with the Lance Corporal in charge of the EPDS, Captain Johnson questioned the identification of the substance. Based on the immediacy of reaction and the burning sensation, Captain Johnson concluded in his report of January 4, 1994 that phosgene oxime was the likely content.<sup>110</sup> Phosgene oxime causes a corrosive type of skin and tissue lesion. It is not a true vesicant, since it does not cause blisters. The vapor is extremely irritating and upon contact, both the vapor and solid cause immediate burning and irritation, followed by wheal-like skin lesions and eye and airway damage. Phosgene oxime is a solid at temperatures below 95 degrees F, and vaporizes at temperatures greater than 95 degrees F (39°C).<sup>111</sup>

Captain Johnson recently stated that representatives from his unit were unable thoroughly to review the Fox tapes to confirm the presence of chemical warfare agent or any other substance because Lieutenant Colonel Killgore ordered that the Fox tapes be released to him.<sup>112</sup> According to Lieutenant Colonel Killgore who had previous Fox training, the tapes indicated the presence of phosgene and mustard but not phosgene oxime.<sup>113</sup> Not having reviewed the tapes himself,

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<sup>107</sup> Photograph of injured British soldier taken by the Sampling Team Leader, August 10, 1991.

<sup>108</sup> Field Manual 3-9, Potential Military Chemical/Biological Agents and Compounds, Choking Agents: Phosgene (CG).

<sup>109</sup> "CW Agents at the Kuwaiti Girls School: Why and Why Not," Information Summary, Persian Gulf War Illness Task Force, August 24, 1997.

<sup>110</sup> Lead Sheet 6753, Interview with Major Johnson, p. 2.

<sup>111</sup> Field Manual 3-9, Potential Military Chemical/Biological Agents and Compounds, Blister Agents (Urticants): Phosgene Oxime (CX).

<sup>112</sup> Lead Sheet 6753, Interview with Major Johnson, p. 2.

<sup>113</sup> Transcript of Interview with Lieutenant Colonel Killgore, October 15, 1997, p. 22.

Captain Johnson was unaware that the Fox vehicles did not register an alarm for phosgene oxime.

The spectra on both sets of Fox tapes indicated a predominant unknown substance in the tank.<sup>114</sup> Because the spectra clearly showed this unknown substance as predominant, the alarms for phosgene and mustard were not a definitive indication that chemical warfare agent was present. The Fox vehicle's mobile mass spectrometer works in such a way that it is pre-programmed to search and alarm for known chemical warfare agents including phosgene and mustard. Since IRFNA is not a chemical warfare agent and is not recorded in the mobile mass spectrometer's library, the Fox could not positively identify it. The mobile mass spectrometer is programmed so that if a substance is detected that is not in its library it will assign it an unknown reading, which duly appeared on both sets of tapes.<sup>115</sup>



Figure 16. Ammunition box containing samples of material in tank<sup>116</sup>

American and British soldiers' noted that their gloves became warm and softened after contact with the material from the tank. This caused concern because there is no known chemical warfare agent capable of breaking down the glove's material.<sup>117</sup> According to Major Watkinson:

"...[the British] Sergeant reported afterwards that he had to come out of the immediate area of contamination to change his gloves. This was as a result of gross contamination on his gloves, and he noted that the gloves started warming up. The implication was that

<sup>114</sup> Fox Tapes from testing at the Girls' School.

<sup>115</sup> Fox Information Paper, Office of the Special Assistant for Gulf War Illnesses, July 29, 1997, p. 9

<sup>116</sup> Photograph of the ammunition box used to store samples taken from the tank. Photo taken by Sampling Team Leader on August 10, 1991.

<sup>117</sup> Lead Sheet5982, Interview with US soldier inside the hot line on the day of the Fox testing, p. 2.

the chemical was reacting with his NBC gloves. He did the obvious and sensible thing, which was to decontaminate them and to exchange them. This again was one of several indications that caused me a little concern, because this chemical that we were dealing with seemed to firstly penetrate NBC cloth, or the cloth of our NBC suit and secondly, in the case of gross contamination it seemed to react with our NBC gloves. If the chemical had been mustard gas, the NBC gloves should have provided sufficient protection and this was another factor that caused doubt about the chemical in the tank being Mustard."<sup>118</sup>

The American Sergeant in the hot line stated that the only conclusion he drew from the condition of his protective gloves was that, "there may have been some acid mixed in the tank."<sup>119</sup> In truth, if IRFNA was present in the tank, then mustard agent could not have been present, because IRFNA would have reacted with it. According to the US Army's Program Manager for NBC Defense Systems, "The presence of chemical [warfare] agents, especially HD [sulfur mustard] in [red fuming nitric acid] RFNA<sup>120</sup> is extremely unlikely. Prior to 1980, RFNA was [apparently] the decontamination material of choice, both in laboratory and HD production facilities."<sup>121</sup>

### **The Second Operation - Subsequent Activity**

According to Captain Johnson, all US forces, with the exception of the 54<sup>th</sup>, departed the area after the Fox tapes were taken. On orders, the 54<sup>th</sup> Chemical Troop secured the area until military police arrived.<sup>122</sup> In the interim, the 54<sup>th</sup> conducted its after action review; recounting events and evaluating operational procedure and equipment functioning. British forces were still active in the area and soldiers from 21<sup>st</sup> EOD Squadron were detailed to provide a guard on the tank and ammunition box to ensure that the samples in the ammunition box were not tampered with or removed.<sup>123</sup>

During the 54<sup>th</sup>'s review several unidentified individuals reportedly approached the tank. Captain Johnson stated that they were located 100-150 meters away and did not approach these individuals because they had already processed through the British command point.<sup>124</sup> They were reportedly Caucasian, wearing desert camouflage uniforms with no noticeable markings or patches. When the men approached the tank, Captain Johnson assumed that they were there to collect the samples. From his vantage point, he was unable to view the men's actions fully.<sup>125</sup> In fact, the samples were not taken away by anyone that day. None of the British forces present that

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<sup>118</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 23.

<sup>119</sup> Lead Sheet 5982, Interview with US soldier inside the hot line on the day of the Fox testing, p. 2.

<sup>120</sup> The difference between inhibited red fuming nitric acid (IRFNA) and red fuming nitric acid (RFNA) is IRFNA contains an inhibitor such as hydrogen fluoride or iodine to impede corrosion of the container.

<sup>121</sup> Letter from Program Manager, NBC Defense Systems, Department of the Army to Director, Investigation and Analysis, Office of the Special Assistant for Gulf War Illnesses, September 11, 1997, p. 2.

<sup>122</sup> Lead Sheet 6753, Interview with Major Johnson, p. 2.

<sup>123</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. 5., Initial Report: Sampling and Assessment of Suspected Chemical Container, August 11, 1991, p. 2.

<sup>124</sup> Lead Sheet 6753, Interview with Major Johnson, p. 2.

<sup>125</sup> Lead Sheet 6753, Interview with Major Johnson, p. 2.

day can recall this incident or any individuals as described by Captain Johnson having passed through the British command point.

However, it is highly likely that these individuals were actually British soldiers from 21<sup>st</sup> EOD Squadron. Unlike US Army units, the British Army does not tend to mark combat jackets with unit insignia. Unit markings, as a rule, are limited to beret badges. In the Gulf these were often substituted for camouflage cloth caps without markings. Officers wear subdued rank markings on their sleeves. At a distance of 100 to 150 meters it would be difficult to see these rank markings. Enlisted soldiers, with the possible exception of a name tag on the left breast, do not wear any markings. It is entirely possible, therefore, that what Captain Johnson saw was in fact British servicemen from 21<sup>st</sup> EOD Squadron carrying out their normal duties.

Several hours later, Task Force Victory military police arrived and the 54th returned to Camp Doha. They were debriefed by the Squadron Commander and the Regimental Commander.<sup>126</sup> The Regimental Commander indicated that he was briefed that the 54<sup>th</sup> Chemical Troop had detected chemical warfare agents in the tank.<sup>127</sup> These results were based on the Fox vehicle alarms. Since Lieutenant Colonel Killgore had taken the Fox tapes, these alarms could not be confirmed.

In reviewing the Fox tapes, Lieutenant Colonel Killgore noticed that there was considerable interference - meaning that the tapes did not give a clean analysis. Based on this interference, he decided that the tapes should be analyzed by a lab with more sophisticated capabilities.<sup>128</sup> Lieutenant Colonel Killgore also stated that he intended to maintain custody of at least one set of samples from the tank. However, because the substance might have been phosgene, he decided that the samples may be too volatile to store at headquarters and that it would be imprudent to transport a sample in his vehicle.<sup>129</sup> Instead, the samples remained in the ammunition box next to the tank. (Figure 16)

Upon returning to headquarters, Lieutenant Colonel Killgore contacted the Chemical Research, Development, and Engineering Center (CRDEC) at Aberdeen Proving Ground, MD. He faxed the Fox tapes, along with a brief paper describing the operation, to the CRDEC for analysis.<sup>130</sup> The CRDEC acknowledged receiving the tapes and conducting an analysis, but to date has not been able to locate copies of this fax or the subsequent analysis done at that time. Likewise, none of the US or UK elements in the Kuwait theater of operations interviewed acknowledged receiving the CRDEC's analysis of the tapes.

On the evening of August 9, Major Watkinson contacted the United Nations Special Commission (UNSCOM) cell in Bahrain and informed Colonel Macel. Colonel Macel informed Lieutenant

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<sup>126</sup> Lead Sheet 6753, Interview with Major Johnson, p. 2.

<sup>127</sup> Lead Sheet 6870, Interview with regimental commander, 11<sup>th</sup> Armored Cavalry Regiment, p. 1.

<sup>128</sup> Transcript of Interview with Lieutenant Colonel Killgore, October 15, 1997, p. 14.

<sup>129</sup> Memorandum for the Office of the Assistant Secretary of Defense for Chemical Biological Matters [OASD (CBM)], Suspect Chemical Container Found in Kuwait City, Kuwait in August 1991, July 29, 1994, p. 6.

<sup>130</sup> Transcript of Interview with Lieutenant Colonel Killgore, October 15, 1997, p. 15.

Colonel Killgore that the UN would be inspecting the tank.<sup>131</sup> According to the Sampling Team Leader's statement, when Major Watkinson contacted the Chemical Weapons Evaluation Team, they were still part of a UN mission. However, when they arrived at the school, they were acting on behalf of the Chemical and Biological Defense Establishment, Porton Down, UK; their mission on behalf of the UN had ended. Aside from the members of the Sampling Team, none of the individuals contacted were aware of this, and thus believed the team was acting on behalf of the UN. The UN denies any involvement in the testing of the tank or taking any of the samples. According to the UN:

"Although it is possible that the people involved in taking samples were at one time temporary UNSCOM inspectors, UNSCOM was not involved in the taking of samples from the tank at the [Kuwaiti] Girls School in Kuwait. Chemicals in Kuwait are clearly not part of UNSCOM's purview although UNSCOM does have interest in the contents of the tank as they probably originated from Iraq."<sup>132</sup>

### **The Third Operation - Obtaining Sampling for Detailed Analysis**

On August 10, 1991, four members of the Sampling Team met with British EOD personnel, Colonel Macel and Lieutenant Colonel Killgore at Beteal Camp, where 21<sup>st</sup> EOD Squadron was located. At the camp, Major Watkinson briefed them about the first and second operations; an officer with EOD experience from the Kuwaiti Army was present during this briefing.<sup>133</sup> They were then briefed by Lieutenant Colonel Killgore and were given a copy of the Fox tapes.<sup>134</sup> The Sampling Team stated that they would take custody of the samples and provide an analysis of the contents of the tank.<sup>135</sup> The Sampling Team then interviewed Major Watkinson, the BDO and BDENGER of the second operation and the injured British soldier.<sup>136</sup>

The Sampling Team, accompanied by Colonel Macel, Lieutenant Colonel Killgore, Major Watkinson and members of 21<sup>st</sup> EOD Squadron then traveled to the Kuwaiti Girls' School to conduct the sampling operation.<sup>137</sup> It was decided that the Sampling Team would take their samples from the bottles stored in the ammunition box rather than reopening the tank. This was accepted by the Sampling Team because the ammunition box had been under 24-hour guard since the second operation to ensure that its contents were not tampered with in any way.<sup>138</sup> The

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<sup>131</sup> Memorandum for the Office of the Assistant Secretary of Defense for Chemical Biological Matters [OASD (CBM)], Suspect Chemical Container Found in Kuwait City, Kuwait in August 1991, July 29, 1994, p. 6.

<sup>132</sup> Message from PGWI-TF to OSAGWI regarding sampling of the tank at the Kuwaiti Girls School, January 22, 1998.

<sup>133</sup> Initial Report: Sampling and Assessment of Suspected Chemical Container, August 11, 1991, pp. 1-2.

<sup>134</sup> Memorandum for the Office of the Assistant Secretary of Defense for Chemical Biological Matters [OASD (CBM)] Suspect Chemical Container Found in Kuwait City Kuwait in August 1991, July 29, 1994, p. 7.

<sup>135</sup> Memorandum for the Office of the Assistant Secretary of Defense for Chemical Biological Matters [OASD (CBM)] Suspect Chemical Container Found in Kuwait City Kuwait in August 1991, July 29, 1994, p. 7.

<sup>136</sup> Clarification of the Sampling Team Leader's Interview, December 17, 1997.

<sup>137</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. 4.

<sup>138</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. 5., Initial Report: Sampling and Assessment of Suspected Chemical Container, August 11, 1991, p. 2.



Sampling Team Leader labeled four tubes from a Sampling and Identification of Biological and Chemical Agents (SIBCA) kit in sequential order. (TAB I) The tubes contained XAD-4 resin<sup>139</sup> which had been sent to the Gulf as a means of transporting samples of chemical warfare agents safely.<sup>140</sup>

The Sampling Team Leader, plus a member of his team and Major Watkinson donned full IPE. They approached the ammunition box carrying further equipment from the SIBCA kit. Using a glass syringe with a four-inch stainless steel internal tube, the two members of the Sampling Team withdrew a sample from one of the bottles within the ammunition box.<sup>141</sup> Major Watkinson stood back and observed this activity. The Sampling Team then selected one of the pre-prepared tubes containing XAD-4 resin at random and proceeded to inject the sample into it through the rubber seal.<sup>142</sup> The first sample reacted violently when introduced into the tube, breaking both the tube and the syringe.

This reaction had potentially exposed the two Sampling Team members to a small amount of liquid agent contamination. They therefore conducted personal decontamination using hypochlorite solution and fuller's earth.<sup>143</sup> They then retired to the decontamination line to assess the events. The Sampling Team decided to remove the rubber seals from the screw top of the pre-prepared tubes so as to attempt to place further liquid samples onto the absorbent contained within them. On returning to the ammunition box this method proved successful and two samples were taken in this way.

The first successful samples were captured in tubes #1 and #3. Therefore, either tube #2 or #4 was broken. The remaining unbroken tube was never utilized.<sup>144</sup>

While Major Watkinson was observing the Sampling Team's activities, he noticed that vapor was again leaking from the tank. Once the Sampling Team had completed its activities, Major Watkinson and a Lance Corporal from 21<sup>st</sup> EOD Squadron acting as BDENGR attempted to reseal the tank. The two members of the Sampling Team remained in IPE and observed Major Watkinson's activities. He removed each seal and, as no silicone sealant was available, he used chewing gum (this had similar properties to silicone sealant) and plaster of paris to fashion new seals.<sup>145</sup> Major Watkinson, the BDENGR and the two members of the Sampling Team then returned to the dirty line and were decontaminated.

The samples taken by the Sampling Team were then sealed in suitable containers to ensure they could not be tampered with. (Figure 17) The Sampling Team Leader, Major Watkinson, and

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<sup>139</sup> XAD-4 is an inert (non-reactive) sample collection medium much like charcoal or chromosorb.

<sup>140</sup> Analysis of Samples from Kuwait: Preliminary Report, Chemical and Biological Defence Establishment, Porton Down, UK, September 24, 1991.

<sup>141</sup> Initial Report: Sampling and Assessment of Suspected Chemical Container, August 11, 1991, p. 3.

<sup>142</sup> Initial Report: Sampling and Assessment of Suspected Chemical Container, August 11, 1991, p. 3.

<sup>143</sup> Initial Report: Sampling and Assessment of Suspected Chemical Container, August 11, 1991, p. 3.

<sup>144</sup> Clarification of the Sampling Team Leader's Interview, December 17, 1997.

<sup>145</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. 5.

Colonel Macel then signed the seals. The remaining bottles of liquid agent stored in the ammunition box were sealed over to the US Military Police who were now guarding the site.<sup>146</sup>

At the end of this operation, the Sampling Team Leader advised that a guard be maintained on the tank pending advice on destruction from the Chemical and Biological Defence Establishment (CBDE) Porton Down, UK. He stated that the samples his team had taken would be treated as forensic evidence and that they would be accompanied by a signatory at all times.<sup>147</sup> They would not be opened until they arrived at CBDE Porton Down, where the seals would be broken in front of witnesses.

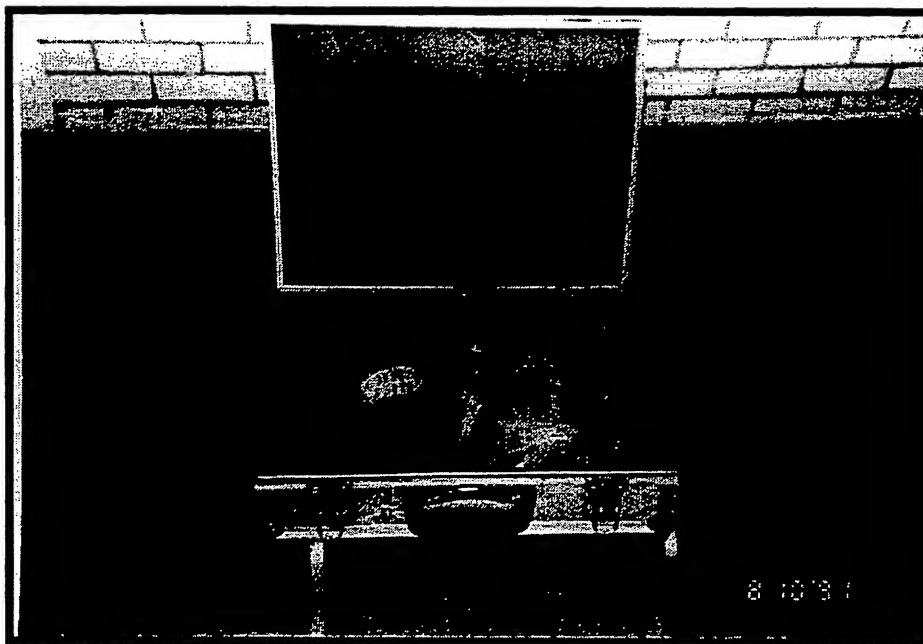


Figure 17. Samples taken for further analysis in the UK<sup>148</sup>

### The Third Operation - Conclusions

In his statement, the Sampling Team Leader noted that:

“The original sample we were trying to take was onto an adsorbent, which is designed to take up chemical weapon agents. My theory, to which I still adhere, is that the nitric acid components reacted very quickly with the adsorbents and they gave off a gas, which just gave an enormous overpressure. So, the overpressure actually exploded the syringe. Chemical weapon agents in general are not actually very reactive chemicals. They have specific organic receptors on which they have their effect. So, they're not reactive. Our

<sup>146</sup> Major Watkinson's Subsequent Report, August 18, 1991, p. 5.

<sup>147</sup> Initial Report: Sampling and Assessment of Suspected Chemical Container, August 11, 1991, p. 4.

<sup>148</sup> Photograph of the samples taken for further analysis in the UK. Photo taken by Sampling Team Leader on August 10, 1991.

sampling kit was designed to deal with CW agents, which, as I say, are not reactive, whereas, this of course was obviously a very reactive chemical.”<sup>149</sup>

Additional factors led the Sampling Team Leader to question the likelihood of this material being chemical warfare agent. According to him:

“In addition, my description of the liquid in the bottle was that it was of very low viscosity. Mustard is a very high viscosity liquid, similar to an engine oil. On top of that, of course I had the descriptions of the injuries that [the British soldier] and Major Watkinson had suffered, and these were again inconsistent with mustard derived burns, but were wholly consistent with a powerful acid, such as nitric.”<sup>150</sup>

The sampling Team Leader did not discuss his views on the content of the tank with Major Watkinson or Colonel Macel.

However, once the Sampling Team Leader had had a chance to discuss the third operation with colleagues in Bahrain, he thought that the agent in the tank may be “fuming nitric acid”.<sup>151</sup> This would be consistent with the use of similar tanks found in Iraq and may account for the detection of mustard agent by some of the detection equipment used during the first two operations. These points are recorded in the Sampling Team Leader’s post-operational report, but this was not copied to Major Watkinson or Colonel Macel at the time.

### **The Third Operation - Subsequent Events**

After the conclusion of the third operation, the samples taken by the Sampling Team were flown back to Bahrain in the custody of the Sampling Team. There they were eventually handed over to a member of the UK Consulate while efforts were made to secure their passage to CBDE Porton Down, UK.<sup>152</sup> As mentioned above, the samples were treated as forensic evidence. Each person to whom the samples were transferred had to sign a custody sheet and ensure that there was no opportunity for the samples to be tampered with in any way.<sup>153</sup>

Meanwhile, 21<sup>st</sup> EOD Squadron regularly inspected the seals on the tank to ensure there was no further leakage.<sup>154</sup> On August 12, 1991 an inspection found that one of the seals had failed. The continued failure of the seals was probably due to the high temperature and the build up of vapor pressure inside the tank. According to Major Watkinson:

“Although we’d done lots of testing, we still hadn’t fulfilled our original mission, which was to stop the vapor coming out of the tank. The various seals [used] should have been

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<sup>149</sup> Transcript of Interview with Sampling Team Leader, October 9, 1997, p. 11.

<sup>150</sup> Transcript of Interview with Sampling Team Leader, October 9, 1997, p. 9.

<sup>151</sup> Initial Report: Sampling and Assessment of Suspected Chemical Container, August 11, 1991, p. 4.

<sup>152</sup> Transcript of Interview with Sampling Team Leader, October 9, 1997, p. 9.

<sup>153</sup> Initial Report: Sampling and Assessment of Suspected Chemical Container, August 11, 1991, p. 4.

<sup>154</sup> Major Watkinson’s Subsequent Report, August 18, 1991, p. 5.

fairly robust. This again raised question marks. What appeared to be happening was that vapor pressure was building up inside the sealed container, which was pressurizing the seals and bursting them. I wouldn't have anticipated that this would occur with mustard gas, which is essentially not volatile and is quite oily. So, the chemical seemed to have quite a high vapor pressure, which was surprising."<sup>155</sup>

Major Watkinson therefore tasked the Commanding Officer (CO) of 3<sup>rd</sup> Troop 21 EOD Squadron, British Royal Engineers to seal the tank again so that it would be suitable for transportation should this be required.<sup>156</sup> Also, as two people had received minor injuries (Major Watkinson and another British soldier) during the first two operations, British Forces were concerned as to whether their IPE could provide adequate protection against the agent in the tank. Major Watkinson therefore tasked the CO of 3<sup>rd</sup> Troop to conduct tests on the British Mk IV NBC suit using the remaining liquid agent stored in the ammunition box.<sup>157</sup> Once these tests had been conducted he was instructed to dispose of any remaining liquid in the bottles for security reasons. The tank itself was deemed too large for anybody to remove.

This operation was slightly delayed in order to allow time for the fabrication of lead dowel plugs. These plugs were machine-tapered pieces of lead that were designed to fit the two bullet holes in the tank.<sup>158</sup>

#### **The Fourth Operation - Permanent Sealing of the Tank at the Kuwaiti Girls' School**

The fourth operation was mounted on August 14, 1991. The CO 3<sup>rd</sup> Troop decided to conduct the testing of the Mk IV suit material first. A test sample of Mk IV suit material and cotton was prepared, representing the inner and outer layers of the normal NBC IPE in service with the British Forces at that time. Three-color detector paper was included between the various layers.<sup>159</sup>

The CO 3<sup>rd</sup> Troop then approached the ammunition box wearing full IPE. A BDENGR, also in IPE, observed the CO's actions. The CO 3<sup>rd</sup> Troop removed the two sample bottles from the ammunition box. He found that the liquid agent had corroded the bottle tops and that only a small amount of liquid agent now remained.<sup>160</sup> Nevertheless, there was still enough to conduct the test.

On contact with the suit, the liquid burned the outer fabric causing it to tear. Within 3 minutes, the liquid had seeped through the charcoal layer. The suit layers then fused together. On examination it was found that the charcoal layer had absorbed much of the liquid agent.

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<sup>155</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 35.

<sup>156</sup> Report on the Resealing of the Salabiyah Chemical Container, August 25, 1991, p. 1.

<sup>157</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 37.

<sup>158</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 43.

<sup>159</sup> Report on the Resealing of the Salabiyah Chemical Container, August 25, 1991, p. 2.

<sup>160</sup> Report on the Resealing of the Salabiyah Chemical Container, August 25, 1991, p. 2.

However, the inner cotton layer was stained and slightly burnt. The three-color detector paper had turned red which suggested the presence of blister agent.<sup>161</sup>

Once the test was complete, the remaining liquid was poured into the sand and mixed with fuller's earth and bleach.<sup>162</sup> This is the standard method of decontaminating blister agent contamination. The bottles were burned at the end of the operation.

During the tests, the CO 3<sup>rd</sup> Troop received a small amount of liquid contamination on his gloves. He noticed heat from areas that had been contaminated and therefore replaced his gloves as soon as possible.<sup>163</sup>

The CO 3<sup>rd</sup> Troop and the BDENGR then commenced the tank sealing operation. They removed the old seals and replaced them with lead dowel plugs. These were hammered in and fixed with self-tapping screws. The seals were then covered with epoxy resin. Once the resin hardened, the areas around the seals were checked with a CAM and three-color detector paper to ensure there were no leaks. There were none.<sup>164</sup>

The CO 3<sup>rd</sup> Troop and the BDENGR then returned to the EPDS and were decontaminated. Following usual procedure, only re-useable items were retained, the rest being destroyed by burning. However, exceptionally the sample of Mk IV suit used to test the liquid agent was decontaminated and retained by 21<sup>st</sup> EOD Squadron.<sup>165</sup> To date, the UK MOD has been unable to locate the sample of Mk IV suit retained at that time by 21<sup>st</sup> EOD.

### **Conclusions of the Fourth Operation**

The liquid agent was found to have corroded the tops of both bottles stored in the ammunition box and, more importantly, rapidly penetrated the sample of Mk IV NBC suit used by the CO 3<sup>rd</sup> Troop in the test. As in previous operations, contamination on the gloves of those handling the liquid agent had caused heat to be produced and the gloves needed replacing. The fact that the three-color detector paper turned red again suggested the presence of blister agent. The method used by the CO 3<sup>rd</sup> Troop to dispose of the remaining liquid from bottles suggests that he thought this was the case.

It is important to note that the end of operation report prepared by the CO 3<sup>rd</sup> Troop was only copied to the British personnel involved in the tank.

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<sup>161</sup> Report on the Resealing of the Salabiyah Chemical Container, August 25, 1991, p. 2.

<sup>162</sup> Report on the Resealing of the Salabiyah Chemical Container, August 25, 1991, p. 2.

<sup>163</sup> Report on the Resealing of the Salabiyah Chemical Container, August 25, 1991, p. 2.

<sup>164</sup> Report on the Resealing of the Salabiyah Chemical Container, August 25, 1991, p. 3.

<sup>165</sup> Report on the Resealing of the Salabiyah Chemical Container, August 25, 1991, p. 2.

## **The Fourth Operation - Subsequent Events**

After the fourth operation, 21<sup>st</sup> EOD Squadron continued to monitor the tank regularly for leaks.

On August 18, 1991, *The Sunday Observer*, a British newspaper, reported:

“A massive drum containing mustard gas agent has been discovered in Kuwait City, providing the first proof that Iraq had chemical weapons ready for use in the Gulf War.”<sup>166</sup>

It went on to say:

“The chemicals would be destroyed by a team from Royal Ordnance.”

In fact, no decision had yet been made about the destruction of the tank because results from CBDE Porton Down's analysis were still awaited. It was not possible, therefore, to formulate a suitable method of disposal for the tank and its contents.

## **CBDE Porton Down Analysis of the Samples Taken from in the Tank**

As reported earlier, the Sampling Team took the samples they had collected from Kuwait to Bahrain. From here it was envisaged that they could be flown direct to the UK. However, the Royal Air Force was no longer operating flights from Bahrain and was, therefore, unable to transport the samples. This caused some considerable delay while alternative travel arrangements were made for the samples. Eventually, the German Luftwaffe flew the samples as far as Munster, Germany.<sup>167</sup> The samples arrived at Munster on September 12, 1991 where two members of CBDE were waiting to collect them. The CBDE staff signed for the samples and returned to CBDE Porton Down which is located in Wiltshire in the UK. The samples arrived at Porton Down on September 13, 1991 where they were signed over to the analytical team.<sup>168</sup>

At CBDE Porton Down the analytical team noted that the two samples had been collected on XAD-4 resin and were labeled sample 1 and sample 3, both dated August 10, 1991.<sup>169</sup>

The Porton Down initial report dated September 24, 1991, stated that: “the samples had a definite yellow/brownish color compared to the original white of the resin. Extraction of the resin with dichloromethane and analysis by gas chromatography/mass spectrometry showed no material of CW [chemical warfare] interest. Extraction of the resin from sample 1 showed 16 mg of nitrate and a pH of 2.2. Resin from sample 3 showed 35 mg of nitrate and a pH of 2.0. An extract of blank resin of similar weight contained less than 0.2 mg of nitrate and had a pH of 6.5. The

<sup>166</sup> “Mustard Gas Reveals Iraqi Chemical War Plan”, *The Sunday Observer*, August 18, 1991, p. 2.

<sup>167</sup> Clarification of the Sampling Team Leader's Interview, December 17, 1997.

<sup>168</sup> Memorandum on collection of samples taken from Kuwaiti Girls School, December 8, 1997.

<sup>169</sup> Analysis of Samples from Kuwait: Preliminary Report, Chemical and Biological Defence Establishment, Porton Down, UK, September 24, 1991.

samples were entirely consistent with the contents of the tank being nitric acid and there is no evidence of any CW dimension."<sup>170</sup> (TAB J)

Although the Porton Down initial report indicated that a detailed report would follow, no such detailed report was ever produced. This is probably because once it had been established that the tank's contents contained no material of chemical warfare interest the matter assumed a low priority, and the aim of producing a detailed report was overtaken by other, more pressing, commitments.

### **Notification of CBDE Porton Down's Findings**

Major Watkinson indicated that he was notified of the Chemical and Biological Defence Establishment's findings in late September 1991.<sup>171</sup> He, in turn, notified Colonel Macel of these results (that the tank did not contain chemical warfare agent, but rather nitric acid).<sup>172</sup> Colonel Macel informed the US military's Central Command, the Defense Reconstruction Assistance Office, the Director of Operations for the Kuwaiti military's general headquarters, and Task Force Victory.<sup>173</sup> However, by the time the results of the sampling had reached the Gulf, Lieutenant Colonel Killgore, along with the 54th Chemical Troop had already left the region. None of the Americans or Britons contacted recalled seeing a formal report of the CBDE Porton Down sampling results from either the UK or the US.

### **Disposal of the Tank**

On September 27, 1991, CBDE Porton Down were informed by Headquarters British Forces (HQBF) Kuwait that they were still concerned about the disposal of the tank. 21<sup>st</sup> EOD Squadron was due to return to the UK on October 2, 1991 and all of its equipment had been packed ready for shipping. It could not therefore carry out procedures to dispose of the tank and its contents. HQBF Kuwait stated that they needed to pass on the correct disposal procedure to the Kuwaiti Army before 21<sup>st</sup> EOD Squadron left Kuwait.<sup>174</sup>

CBDE Porton Down responded on September 30 1991. They advised that the tank may contain up to two tons of nitric acid and that this would be extremely difficult to dispose of safely.<sup>175</sup> Untrained personnel should not attempt it, nor should disposal be attempted in place. As the tank was in good condition and the bullet holes effectively sealed, it was suggested that the tank could be sold to the local chemical industry or, if this failed, that the chemical industry might be paid to remove the tank. Another option was to invite Iraq to dispose of the tank. Contemporary

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<sup>170</sup> Analysis of Samples from Kuwait: Preliminary Report, Chemical and Biological Defence Establishment, Porton Down, UK, September 24, 1991.

<sup>171</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 46.

<sup>172</sup> Transcript of Interview with Colonel Macel, October 16, 1997, p. 31.

<sup>173</sup> Transcript of Interview with Colonel Macel, October 16, 1997, p. 11.

<sup>174</sup> Signal traffic from HQBF Kuwait to CBDE Porton Down, PR271100Z September 1991, p. 1.

<sup>175</sup> Signal traffic from CBDE Porton Down to HQBF Kuwait, 301530Z September 1991.

evidence suggests that the Kuwaiti MOD decided to let companies tender for the disposal of the contract.<sup>176</sup>

On October 29, 1991, Passive Barriers, which had originally discovered the tank, notified Brown & Root that the container held fuming nitric acid.<sup>177</sup> According to the Brown & Root supervisor, Passive Barriers had access to a laboratory in the UK that had received samples of the tank's contents.<sup>178</sup> A statement made by an employee of Passive Barriers suggests that another sample of the tank's contents had been sent to CBDE Porton Down for analysis.<sup>179</sup> The UK MOD researched this claim and could find no evidence that any samples, other than those taken by the Sampling Team on August 10, 1991, were taken from the tank and returned to the UK for analysis. It was more likely that advice was sought from HQBF Kuwait who were already aware of the CBDE Porton Down analysis and that the results of this analysis was passed to Passive Barriers.

On October 30, 1991, the Brown & Root supervisor informed KERO of the contents of the tank. KERO then requested that Brown & Root provide disposal options and cost estimates. However, neither Brown & Root nor Passive Barriers handled the tank's disposal. A Passive Barriers employee has stated that the Kuwaiti Fire Service removed the tank while his company was still tendering for disposal for the contract. According to him, the tank was taken into the desert and burned.<sup>180</sup>

Efforts to confirm Kuwaiti Fire Service involvement in the tank's disposal continue.

## **PUBLIC REVIEW OF THE CASE**

### **Subsequent Events in the US - Captain Johnson's Report**

In January 1994, then-Captain Johnson, who had been the Commander of the 54<sup>th</sup> Chemical Troop, was troubled by the absence of a formal report on the events at the Kuwaiti Girls' School. This was because "the history of my unit's chemical detection actions with 21<sup>st</sup> British EOD Royal Engineers, was not properly documented. I had not seen any official or unofficial record of those actions."<sup>181</sup> He drafted a report detailing events at the school for use in course instruction focusing on lessons learned in NBC defensive operations during the Gulf War. The report was reviewed by the chain-of-command, US Army Infantry Training School, which

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<sup>176</sup> Letter from Brown & Root to Contracting Officer, Kuwaiti Emergency Recovery Office dated October 30, 1991.

<sup>177</sup> Letter from American prime contractor to Contracting Officer, Kuwaiti Emergency Reconstruction Office dated October 30, 1991.

<sup>178</sup> Lead Sheet 5981, Interview with program manager for Brown & Root Kuwaiti school reconstruction effort, p. 2.

<sup>179</sup> Statement of Passive Barriers employee, February 10, 1998.

<sup>180</sup> Statement of Passive Barriers employee, February 10, 1998.

<sup>181</sup> Written Testimony by the former Commander of the 54<sup>th</sup> Chemical Troop, US Army, before the Subcommittee on Human Resources and Intergovernmental Relations, United States House of Representatives, December 10, 1996, p. 1.



authorized its use in instruction.<sup>182</sup> This report was eventually obtained by staff members of the Senate Committee on Banking, Housing and Urban Affairs, who were investigating allegations of chemical agent use in the Gulf War. Senate hearings held in the summer of 1994, thrust the events at the Kuwaiti Girls' School into the public eye.

### **The Senate Committee on Banking, Housing and Urban Affairs Investigation**

Senate investigators focused on three key points: 1) the validity of the tests run, 2) the nature of the material in question, and 3) the injury sustained by the British soldier during testing. The Committee staff pointed out that multiple tests were conducted, using various different types of detection equipment, all of which provided positive alarms for chemical warfare agent.<sup>183</sup>

Committee staff members maintained that the substance in the container was oily in nature and brown in color, both of which are indicators for mustard agent.<sup>184</sup> Regarding the British soldier's injury, the staff members concluded that the immediate reaction and burn associated with contact to the material was consistent with phosgene oxime.<sup>185</sup> Based on the evidence presented, the Senate Committee concluded that it was likely that the tank had contained a mix of chemical warfare agents.<sup>186</sup>

The Senate Committee concluded that 21 tests were conducted on the contents of the tank.<sup>187</sup> However, it appears that the Committee counted the Fox alarms and their corresponding spectrum printouts as separate tests, when in fact, they are not. Additionally, the Committee noted MM-1 alarms for phosgene oxime when, in fact, the MM-1s alarmed for phosgene not phosgene oxime.<sup>188</sup> A table illustrating the tests conducted at the Girls' School in August 1991, the different detectors used for each, their respective outcomes, and reasons to question these outcomes is at Figure 18.

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<sup>182</sup> Lead Sheet 6753, Interview with Major Johnson, p. 1.

<sup>183</sup> U.S. Chemical and Biological Warfare-Related Dual Use Exports to Iraq and Their Possible Impact on the Health Consequences of the Persian Gulf War, Committee on Banking, Housing and Urban Affairs, United States Senate, October 7, 1994, p. 18.

<sup>184</sup> U.S. Chemical and Biological Warfare-Related Dual Use Exports to Iraq and Their Possible Impact on the Health Consequences of the Persian Gulf War, Committee on Banking, Housing and Urban Affairs, United States Senate, October 7, 1994, p. 8.

<sup>185</sup> U.S. Chemical and Biological Warfare-Related Dual Use Exports to Iraq and Their Possible Impact on the Health Consequences of the Persian Gulf War, Committee on Banking, Housing and Urban Affairs, United States Senate, October 7, 1994, p. 14.

<sup>186</sup> U.S. Chemical and Biological Warfare-Related Dual Use Exports to Iraq and Their Possible Impact on the Health Consequences of the Persian Gulf War, Committee on Banking, Housing and Urban Affairs, United States Senate, October 7, 1994, p. 16.

<sup>187</sup> U.S. Chemical and Biological Warfare-Related Dual Use Exports to Iraq and Their Possible Impact on the Health Consequences of the Persian Gulf War, Committee on Banking, Housing and Urban Affairs, United States Senate, October 7, 1994, pp. 7-11.

<sup>188</sup> U.S. Chemical and Biological Warfare-Related Dual Use Exports to Iraq and Their Possible Impact on the Health Consequences of the Persian Gulf War, Committee on Banking, Housing and Urban Affairs, United States Senate, October 7, 1994, p. 11.

Detector	Test #	Outcome	Reasons to Question Outcome
CAM	1, 14	Registered 8 bars on scale for mustard agent	IRFNA known to cause CAM to false positive for mustard agent <sup>189</sup>
One-Color Detector Paper	2, 4	Negative response	British detector paper used should have turned blue, not brown. <sup>190</sup>
Three-Color Detector Paper	3, 5, 12, 13	Pink; pink/orange, both deemed positive for mustard agent	IRFNA is suspected of causing a false positive for blister agent based on the theoretical reaction between the inhibitor and the dyes in the paper. (Note: RFNA used in laboratories does not cause this reaction.) <sup>191</sup>
M18A2	6 - 11	(4) blue; (2) yellow eventually turning blue	Major Watkinson stated that the M18A2 tubes did not respond as was expected in the presence of true chemical warfare agent, which is why he ended up testing it six times. <sup>192</sup>
MM-1 Mobile Mass Spectrometer used on Fox Vehicle	15-18	Alarms received for mustard agent and phosgene	Corresponding spectra identified an unknown substance with atomic mass unit 46 at 100% relative intensity which is reflective of pure RFNA. <sup>193</sup>

Figure 18. Tests conducted at the Kuwaiti Girls' School in August 1991.

In committee testimony, DoD stated that when American scientists at CRDEC learned of the British determination that the content was nitric acid, they compared the Fox tapes to the mass spectrum of nitric acid. The spectrum reportedly matched nitric acid in all four categories and in the correct proportions.<sup>194</sup> The scientists also confirmed that neither mustard agent nor phosgene oxime were present in the tank.<sup>195</sup> These statements made by DoD were incorrect and somewhat misleading. In truth, only a single peak, not three or four, would register for nitric acid on the Fox vehicle's MM-1. Additionally, the Fox tapes, which DoD was unable to produce for review

<sup>189</sup> Email message from VII Corps RBBS to all MSC's, CAM burnout, 191741 Feb 91.

<sup>190</sup> Major Watkinson's Initial Report, August 7, 1991, pp. 1-2; Transcript of Interview with Major Watkinson, October 16, 1997, pp. 6-8.

<sup>191</sup> Major Watkinson's Initial Report, August 7, 1991, pp. 1-2; Transcript of Interview with Major Watkinson, October 16, 1997, pp. 7-8.

<sup>192</sup> Transcript of Interview with Major Watkinson, October 16, 1997, p. 14.

<sup>193</sup> Letter from Project Manager, NBC Defense Systems to Director of Investigation and Analysis, Office of the Special Assistant for Gulf War Illnesses, September 11, 1997; Letter from Bruker Daltonics, December 15, 1997; Letter from the National Institute of Standards and Technology, December 19, 1997.

<sup>194</sup> Letter from Deputy for Chemical/Biological Matters, Office of the Assistant Secretary of Defense to the Chairman, Senate Committee on Banking, Housing, and Urban Affairs, p. 2.

<sup>195</sup> Letter from Deputy for Chemical/Biological Matters, Office of the Assistant Secretary of Defense to the Chairman, Senate Committee on Banking, Housing, and Urban Affairs, p. 2.

by the Committee, clearly show no alarm was received for phosgene oxime. Alarms were received only for mustard agent and phosgene. (TAB G)

### UK Provision of Information

DoD asked CBDE Porton Down, UK for an account of, and results from, the testing procedure which it had carried out on the samples taken from the tank. Based on Porton Down's response, the DoD incorrectly inferred that portions of the NBC suit worn by the injured British soldier had been returned to CBDE Porton Down for testing.<sup>196</sup> The Committee heard testimony to the contrary. In fact, DoD officials had misinterpreted the information supplied by CBDE Porton Down. The suit, like all other used protective clothing, was burned in accordance with standard operating procedure. The information in CBDE Porton Down's letter referred rather to the testing of the NBC suit materials during the fourth operation. However, DoD were unaware that this operation had ever been conducted and therefore assumed that CBDE Porton Down must be referring to the injured soldier's NBC suit material.

Despite the information DoD presented indicating that the tank's content was not chemical warfare agent, but rather IRFNA, it lacked contemporary evidence to prove or disprove the prior testing.<sup>197</sup> There was no apparent explanation for why IRFNA would be present at the school, the tank's disposition remained unknown, and neither the original Fox tapes faxed to CRDEC in 1991 nor CBDE Porton Down's analysis of the samples taken from the tank, could be accounted for. Further, the Senate Committee could not understand how the DoD could issue awards to the 54<sup>th</sup> Chemical Troop for discovery of chemical warfare agent in Kuwait if, as it was now claiming, agent was never present. This apparent contradiction was cited by reporters and authors suspicious of DoD's conclusions.<sup>198</sup> Lastly, all evidence presented by either the UK or US against chemical warfare agent being in the tank was dated 1994 rather than 1991<sup>199</sup> - raising concerns that the analysis was biased.

At the time, neither the Committee nor the DoD was aware that the United Kingdom's practice on the release of official information is governed by the non-statutory Code of Practice.<sup>200</sup> The British government is obliged to provide information on its policies, actions and decisions, but there is no commitment to the disclosure of pre-existing documents. Consequently, requests for information are often met by drawing the necessary information from existing documents rather

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<sup>196</sup> Letter from Deputy for Chemical/Biological Matters, Office of the Assistant Secretary of Defense to the Chairman, Senate Committee on Banking, Housing, and Urban Affairs, p. 2.

<sup>197</sup> U.S. Chemical and Biological Warfare-Related Dual Use Exports to Iraq and Their Possible Impact on the Health Consequences of the Persian Gulf War, Committee on Banking, Housing and Urban Affairs, United States Senate, October 7, 1994, p. 17.

<sup>198</sup> *60 Minutes*, March 19, 1995., "Gulf war sequel: Claims, counterclaims," *USA Today*, March 12, 1995, p. 8A., "Drumbeat of Denial," *Soldier of Fortune*, May 1997, pp. 38-39., Eddington, Patrick G., Gassed in the Gulf, Insignia Publishing Company, Washington, DC, March 1997, pp. 48-49, 120-121, 126-129.

<sup>199</sup> Neither the Fox tapes or US analysis of them was ever provided in its original form. All UK materials including analysis of samples on resin, were only referenced in letters. The actual reports from 1991 were not provided.

<sup>200</sup> For more information about the UK Code of Practice on Access to Government Information see [http://www.mod.uk/pol\\_docs/dcill1997.htm](http://www.mod.uk/pol_docs/dcill1997.htm) or <http://www.open.gov.uk/m-of-g/foihome.htm>

than providing the documents themselves. When the letters provided to the DoD by the UK in 1994 are compared to the source documents dated 1991, the texts are virtually identical.

### **Presidential Advisory Committee on Gulf War Veterans' Illnesses Investigation**

In addition to Senate Committee review, the case was investigated by the Presidential Advisory Committee on Gulf War Veterans' Illnesses (PACGWVI). The PACGWVI was established by President Clinton to ensure an independent, open, and comprehensive examination of health concerns related to Gulf War service. In May 1997, this 12-member panel, consisting of specialists in a variety of disciplines, concluded that the tank at the Girls School contained chemical warfare agent. This determination was based on multiple positive detections as well as the lack of any contrary analysis contemporary with events in 1991.<sup>201</sup> In July 1997, UNSCOM officials testified to the PACGWVI that their inspections of Iraq's chemical weapons program had yielded no evidence that Iraq moved chemical weapons into Kuwait.<sup>202</sup> In September 1997, DoD testified on the events as described in this narrative providing insight into the school's use by the Iraqis, and the discovery of the previously lost Fox tapes.<sup>203</sup> The PACGWVI did not amend its May 1997 conclusion.

### **Subsequent Events in the UK**

In October 1994, the investigations and concerns of the US Senate Committee were taken up in the United Kingdom. On October 13 and 14, 1994, press articles appeared in the *Evening Standard* and *The Times* newspapers which reported details of the Kuwaiti Girls' School incident.<sup>204</sup> These articles quoted from Major Watkinson's initial report on the first operation at the tank. This had suggested that the liquid in the tank might have been mustard agent. This report had been published during the US Senate investigation without the knowledge of the UK MOD. The articles also quoted from the testimony of then-Captain Johnson. As a result of these press articles, British Members of Parliament raised questions regarding the presence of chemical agent at the Kuwaiti Girls' School.

The British Government responded that the contents of the tank had been analyzed at CBDE Porton Down and the results were consistent with the presence of nitric acid; there was no evidence of chemical warfare agent(s). On November 12, 1995, *The Mail on Sunday* published an interview with an ex-member of the British Army who had formerly served as a sergeant in

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<sup>201</sup> Presidential Advisory Committee on Gulf War Veterans' Illnesses, Public Meeting transcript, Charleston, South Carolina, May 7, 1997.

<sup>202</sup> Extract of Testimony by UNSCOM representatives to the Presidential Advisory Committee on Gulf War Veterans' Illnesses meeting in Buffalo, NY, July 29, 1997.

<sup>203</sup> Presidential Advisory Committee on Gulf War Veterans' Illnesses, Public Meeting transcript, Alexandria, Virginia, September 4, 1997.

<sup>204</sup> "Chemical Weapons Used in Gulf War", *Evening Standard*, October 13, 1994, p. 23., "Allies Found Iraq Stored Blister Agent in Kuwait", *The Times*, October 14, 1994, p. 15.

21<sup>st</sup> EOD Squadron.<sup>205</sup> This sergeant was the Bomb Disposal Engineer involved in removing samples from the tank during the second operation. He specifically referred to the results of the testing that had indicated the presence of mustard agent. He also questioned CBDE Porton Down's letter to Parliament of January 25, 1995, which he thought had suggested that CBDE Porton Down had tested the injured British soldier's NBC suit.<sup>206</sup> In fact, as indicated above, CBDE Porton Down's letter had simply referred to "damage to the NBC suit material" and stated that "samples collected in Kuwait City were provided to CBDE Porton Down for analysis."<sup>207</sup> The samples referred to were the liquid samples taken by the Sampling Team during the third operation. The damage to the NBC suit material was based on anecdotal reporting, as well as the testing undertaken by the CO 3<sup>rd</sup> Troop, 21<sup>st</sup> EOD Squadron during the fourth operation at the Kuwaiti Girls' School.

### **The UK/US investigation**

Despite reassurances by both UK and US governments, questions have continued to be raised about this incident. This, coupled with the overlap in jurisdiction at the national and organizational level during the four separate operations at the Kuwaiti Girls' School prompted the DoD and UK MOD to conduct a joint review of the events surrounding the discovery, testing and disposal of the tank. Investigators from the US's Office of the Special Assistant for Gulf War Illnesses working in conjunction with the UK's Gulf Veterans' Illnesses Unit and analysts from the US Intelligence Community set about trying to address issues of concern. Obtaining contemporary information about the testing and analysis of the liquid in the tank was a priority. In addition, it was important to determine whether the equipment which had been used at the time would register a false positive in the presence of a strong oxidizer such as IRFNA.

The UK/US investigation involved interviewing at least twenty-seven people who had been directly involved with the discovery, investigation and disposal of the tank in 1991, at least thirteen UK and fifteen US Government agencies, the United Nations, the Government of Kuwait and three non-governmental organizations.

### **Assessment of the Fox Tapes**

In early 1997, unable to account for the original Fox tapes, the Department of Defense initiated tests utilizing the MM-1 mobile mass spectrometer to determine whether if IRFNA could cause the Fox vehicle to false alarm.<sup>208</sup> The Department of Defense was not at that time aware that a copy of the Fox tapes was still held on file at Porton Down and the MOD was not aware of DoD's difficulty in producing a copy. Since IRFNA was not readily available, the tests were

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<sup>205</sup> Presidential Advisory Committee on Gulf War Veterans' Illnesses, Public Meeting transcript, Charleston, South Carolina, May 7, 1997.

<sup>206</sup> "Why is the Government lying?" *The Mail On Sunday - Night and Day*, 12 November 1995, p. 1.

<sup>207</sup> *Written Answers*, 25 January 1995, p. 282.

<sup>208</sup> Memorandum Through the Deputy Assistant Secretary of Defense for Chemical/Biological Matters, Testing Response of Chemical Detection Equipment to Red Fuming Nitric Acid, April 11, 1997.

conducted using red fuming nitric acid (RFNA).<sup>209</sup> The difference between inhibited red fuming nitric acid (IRFNA) and red fuming nitric acid (RFNA) is that IRFNA contains an inhibitor such as hydrogen fluoride or hydrogen iodine to impede corrosion of the container.

During the 1997 testing, the MM-1, which is used on the Fox vehicle, initially alarmed for cyclosarin. The PACGWI could not understand why the MM-1 alarmed for cyclosarin when exposed to RFNA during the 1997 testing, yet it alarmed for mustard agent and phosgene at the Girls' School in 1991, which the DoD claimed was IRFNA.<sup>210</sup> Again, it is important to note that these tests were conducted using research grade RFNA rather than operational Iraqi IRFNA. According to the Project Manager, NBC Defense Systems at the US Army Chemical Biological Defense Command (CBDCOM)<sup>211</sup>, this difference may account for a variant in the alarm between the MM-1 laboratory trials versus the testing at the Kuwaiti Girls School; however, the spectrum remained the same.<sup>212</sup> Analysts at the Central Intelligence Agency (CIA) and DoD are also concerned about possible contamination of the samples used during the Fox testing at the Kuwaiti Girls' School. Contamination could be caused by the corrosive effects of IRFNA on the sampling tube or the plunger used to take the sample. This difference in chemical composition, resulting from IRFNA reacting with the sampling tube or plunger, from that of the controlled CBDCOM sample, could have caused the Fox vehicles at the Kuwaiti Girls' School to register a different alarm than the Fox vehicle used in CBDCOM testing. Regardless, when comparing the 1991 Girls' School testing to that in 1997, one must note that both the 1991 and the 1997 spectrum analysis of the respective samples confirmed the presence of an unknown substance.<sup>213</sup> The 1997 testing also yielded valuable information in the form of a detection algorithm for RFNA. This unknown substance, as it was recorded, had an atomic mass unit 46 at 100% relative intensity, which is reflective of the pure RFNA.

In July 1997, during routine contact between DoD and MOD, DoD reported their difficulty in tracing copies of the Fox tapes from the second operation in 1991. The MOD therefore retrieved copies from CBDE Porton Down, where they were held, and forwarded them to DoD. The tapes were resubmitted to CBDCOM, and the Project Manager for NBC Defense Systems there responded as follows:

"None of the initial warnings for either phosgene or mustard agent were verified by the MM-1 mass spectrometers located in either of the two Fox NBC reconnaissance vehicles that were at the site. Personnel followed the proper and complete suspected agent verification scenario which included a second sample analysis and comparison to an

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<sup>209</sup> Letter from Project Manager, NBC Defense Systems to Director of Investigation and Analysis, Office of the Special Assistant for Gulf War Illnesses, September 11, 1997, p. 2.

<sup>210</sup> Presidential Advisory Committee on Gulf War Veterans' Illnesses, Public Meeting transcript, Charleston, South Carolina, May 7, 1997.

<sup>211</sup> CBDCOM is the parent command of the Edgewood Research, Development and Engineering Center (ERDEC) and the successor organization to the Chemical Research, Development and Engineering Center (CRDEC).

<sup>212</sup> Letter from Project Manager, NBC Defense Systems to Director of Investigation and Analysis, Office of the Special Assistant for Gulf War Illnesses, September 11, 1997, p. 1.

<sup>213</sup> Memorandum Through the Deputy Assistant Secretary of Defense for Chemical/Biological Matters, Testing Response of Chemical Detection Equipment to Red Fuming Nitric Acid, April 11, 1997.

internal library. In every retest, the MM-1 reported the spectrum analysis as 'unknown.' In the cases where the crew renamed this 'unknown' as an 'extra substance' in the library, the MM-1 identified the spectra as that 'extra substance'. Ion mass 46 at 100% intensity was reported on every MM-1 tape, except one, and is identical to trials conducted at CBDCOM [Chemical/Biological Defense Command] using research grade red fuming nitric acid (RFNA) ... The tapes from one of the Fox NBC reconnaissance vehicles indicate a mass 69 ion with 100% intensity. While this is a deviation from all other analyses which had mass 46 at 100%, it is easily explained. Coupled with the presence of other specific ions in significant amounts, this duplicates other known incidents of the fluorocarbon calibration gas escaping into the analysis system. Each of the three tapes from the MM-1 on this vehicle contains the presence of these peaks, indicating sample contamination with calibration gas. Subtraction of the calibration gas results in spectra which are similar to those of the other vehicle where ion mass 46 is the major component in the sample."<sup>214</sup>

Additional analysis of the 1991 Fox tapes conducted by Bruker Daltonics, the manufacturer of the MM-1 mobile mass spectrometer, and by the US Department of Commerce, National Institute of Standards and Technology, confirmed this assessment. According to a representative from the National Institute of Standards and Technology:

"After examining the tapes from two Fox vehicles ... it is clear that there is no mass spectral evidence confirming the presence of either of the two CW [chemical warfare] agents reported (phosgene and HD [sulfur mustard]). ... the general finding that the largest peak is  $m/z$  46, the principal peak in nitrogen dioxide, is consistent with the introduction of [inhibited] red fuming nitric acid into the mass spectrometers of both vehicles."<sup>215</sup>

A representative from Bruker Daltonics offered the following assessment:

"The tape [from vehicle C-23] shows that the system passed its automatic test on start-up indicating there were no major system failures. Approximately thirty minutes later, the system indicates an initial alarm that phosgene may be present.... Immediately, as called for to confirm the alarm in SOP [standard operating procedure], a spectrum is taken ... and the search of the 60 compound library indicates that the compound is unknown (not in the library of [chemical warfare] agents). Furthermore, it assigns the unknown compound a concentration ... approximately 200 times as intense as the ions used to initially alarm for Phosgene.... The most intense ion in the spectrum is mass 46 (100%).... For vehicle C-26, it appears from the spectrum at 12:51, that this system may have both hydrocarbon background and calibration compound. In this spectrum [mass] 69 is actually larger than the mass 46 (100% versus 62.3%).... At 13:01, mass 46 is now 100% ... the complete spectra in these tapes do not confirm the presence of CWA in the tank in

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<sup>214</sup> Letter from Project Manager, NBC Defense Systems to Director of Investigation and Analysis, Office of the Special Assistant for Gulf War Illnesses, September 11, 1997, pp. 1, 2.

<sup>215</sup> Letter from the National Institute of Standards and Technology, December 19, 1997.

question, but rather [are] consistent with the independent analysis that the brown oily liquid was in fact [inhibited red] fuming nitric acid.<sup>216</sup>

## ASSESSMENT

The assessment for this incident is that chemical warfare agent was "definitely not" present at the Kuwaiti Girls' School. This assessment is based on the following facts that have already been addressed:

- Analysis of the Fox tapes indicates chemical warfare agent was not present;
- Contemporary CBDE Porton Down analysis of the samples on resin shows no chemical weapons material present;
- Safety Officer for the US Army Corps of Engineers, Kuwaiti Emergency Recovery Office exhibited no symptoms corresponding to chemical agent exposure after unprotected contact with the tank;
- Injuries sustained by Major Watkinson and the British soldier were not consistent with the chemical agents alarmed for (though the soldier's injury was potentially similar to effects of phosgene oxime exposure, no alarm was ever received for phosgene oxime being present);
- No known chemical warfare agent is capable of destroying NBC protective gear;
- No known chemical warfare agent gives off brown or red-brown vapor;
- Mustard agent is physically too persistent to have evaporated from the sample dish used during the Fox testing;
- Phosgene rapidly evaporates, and given the high temperatures in the desert, it would have diffused out of the tank before the initial investigation of the tank by 21<sup>st</sup> EOD Squadron;
- Iraq is not known to have had phosgene in its inventory.

The possibility that the tank actually contained IRFNA is assessed as "definitely." This is based on the following facts:

- The Fox tapes clearly show the presence of mass 46 ion at 100%, which is indicative of IRFNA;

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<sup>216</sup> Letter from Bruker Daltonics, December 15, 1997, pp. 1-2.



- Contemporary CBDE Porton Down analysis of the samples on the resin shows high nitrate readings, consistent with the contents being nitric acid;
- The chemical agent monitor was known to register a false positive (8 bars on mustard) for IRFNA;
- IRFNA would be expected at the school, because it was used as a SILKWORM missile maintenance and test facility by the Iraqis;
- The tank itself was identified by the Sampling Team Leader as a type used by the Iraqis to store IRFNA
- The Safety Officer for the US Army Corps of Engineers, Kuwaiti Emergency Recovery Office indicated that the vapor smelled like nitric acid;
- IRFNA fumes are a red-brown vapor;
- IRFNA can cause immediate blistering of skin upon contact as happened on the British soldier;
- IRFNA can penetrate and destroy material used in NBC protective gear as happened in this case.

## CONCLUSION

All personnel involved in the testing of the tank at the Kuwaiti Girls' School performed their duties in an exemplary manner. Proper planning and coordination were made between UK and US forces; all field equipment was used properly; all technical resources were employed; and following proper NATO procedures, samples were taken and transported for laboratory analysis.

The equipment utilized by UK and US Armed Forces operated in accordance with its design. The Fox did not have a spectrum for IRFNA in its library, and thus could not positively identify it as such. The other detectors were overwhelmed by such a strong interferent as IRFNA, for which none of the detectors were designed. It is the policy of both the UK and US militaries to set chemical weapons detector parameters loosely so as to err on the side of caution - i.e. to accept a false positive response, rather than run the risk that a genuine positive might be overlooked. From the safety perspective, it is more preferable to have a small number of false positives, which cause soldiers to take an additional measurement or don protective gear, rather than to take the chance that a false negative would result in injury to troops. This incident was clearly a case in point. While IRFNA is not a chemical warfare agent, it poses a serious health hazard to anyone in contact with it. A description of IRFNA and its related health hazards is at TAB D.

Several key factors prevented a rapid inquiry and assessment of these events. The sensitive nature of the testing limited distribution of pertinent information. This meant that some individuals ended their involvement with limited information and unanswered questions about the nature of the tank's contents. A summary of individuals' knowledge regarding the Kuwaiti Girls' School is at TAB F. The numerous and varied groups having contact with the tank further hindered investigations, as it was thought for a while that the various operations may have been unrelated incidents. Finally, inconsistencies in reporting made an early assessment impossible. Individuals often had to be interviewed several times, and documents were repeatedly analyzed. This process led to several issues of concern being identified and addressed. This, in turn, led to a more complete picture of events at the school from March 1991 until November 1991. A breakout of events and those involved is at TAB G. The key lessons learned by the US DoD from this investigation are at TAB K.

## ***TAB A - LIST OF ACRONYMS AND ABBREVIATIONS***

ACR .....	Armored Cavalry Regiment
BDENGR .....	Bomb Disposal Engineer
BDO .....	Bomb Disposal Officer
CAM .....	Chemical Agent Monitor
CBDCOM .....	Chemical/Biological Defense Command
CBDE .....	Chemical and Biological Defense Establishment
CIA .....	Central Intelligence Agency
CO .....	Commanding Officer
CP .....	Command Post
CRDEC .....	Chemical Research, Development and Engineering Center
CW .....	Chemical Warfare
CWA .....	Chemical Warfare Agent
DoD .....	Department of Defense
DRAO .....	Defense Reconstruction Assistance Office
EOD .....	Explosive Ordnance Disposal
EPDS .....	Emergency Personnel Decontamination Station
ERDEC .....	Edgewood Research, Development and Engineering Center
GVIU .....	Gulf Veterans Illnesses Unit
H .....	Mustard
HD .....	Sulfur Mustard
IAD .....	Investigation and Analysis Directorate
ICP .....	Incident Command Post
IPE .....	Individual Protection Equipment
IRFNA .....	Inhibited Red Fuming Nitric Acid
KERO .....	Kuwaiti Emergency Recovery Office
MOD .....	Ministry of Defence
NATO .....	North Atlantic Treaty Organization
NBC .....	Nuclear, Biological & Chemical
OSAGWI .....	Office of the Special Assistant for Gulf War Illnesses
PACGWVI .....	Presidential Advisory Committee on Gulf War Veterans' Illnesses
PGWITF .....	Persian Gulf War Illnesses Task Force
RFNA .....	Red Fuming Nitric Acid
SIBCA .....	Sampling and Identification of Biological & Chemical Agents
SOP .....	Standard Operating Procedure
UN .....	United Nations
UNSCOM .....	United Nations Special Commission on Iraq
USALOK .....	US Army Liaison Officer Kuwait

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## ***TAB C - METHODOLOGY FOR CHEMICAL INCIDENT INVESTIGATION***

The DoD requires a common framework for our investigations and assessments of chemical warfare agent incident reports, so we turned to the United Nations and the international community which had experience concerning chemical weapons, e.g. the United Nations' investigation of the use of chemical weapons during the 1980-88 Iran-Iraq war. Because the modern battlefield is complex, the international community developed investigation and validation protocols<sup>1</sup> to provide objective procedures for possible chemical weapons incidents. The standard that we are using is based on these international protocols and guidelines that includes:

- A detailed written record of the conditions at the site
- Physical evidence from the site such as weapons fragments, soil, water, vegetation, or human or animal tissue samples
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses
- Multiple analyses
- Review of the evidence by an expert panel.

While the DoD methodology for investigating chemical incidents (Figure 1) is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence often was not collected at the time of an event. Therefore, we cannot apply a rigid template to all incidents, and each investigation must be tailored to its unique circumstances. Accordingly, we designed our methodology to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. The major efforts<sup>2</sup> in our methodology are:

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<sup>1</sup> "Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction," April 29, 1997. This Chemical Weapons Convention was opened for signature in Paris, France, on January 13, 1993. It has been signed by 165 States and ratified or acceded by 106 States (as of February 1998). It was signed by the U.S. on Jan 13, 1993 and ratified on April 25, 1997. Part XI of the Convention, "Investigations in Cases of Alleged Use of Chemical Weapons," details some of the procedures. Other protocols and guidelines were found in Methodology and Instrumentation for Sampling and Analysis in the Verification of Chemical Disarmament, The Ministry for Foreign Affairs of Finland, Helsinki, Finland, 1985; Verification Methods, Handling, and Assessment Of Unusual Events In Relation To Allegations of the Use of Novel Chemical Warfare Agents, Consultant University of Saskatchewan in conjunction with the Verification Research Unit of External Affairs and International Trade Canada, March 1990; and Handbook for the Investigation Of Allegations of the Use of Chemical or Biological Weapons, Department of External Affairs, Department of National Defence, Health and Welfare Canada, and Agriculture Canada, November 1985. US Army FM 3-4/USMC FMFM 11-9, NBC Protection, May 1992; Army FM 8-285/NAVY NAVMED P-5041/AFJMAN 44-149/MARINE CORPS FMFM 11-11 (adopted as NATO FM 8-285), Treatment Of Chemical Agent Casualties and Conventional Military Chemical Injuries, US Army FM 19-20, Law Enforcement Investigations, Headquarters, Department of The Army, November 25, 1985, and other DoD investigational procedures contributed ideas for the development of this DoD methodology.

<sup>2</sup> The MOD has carried out similar procedures, locating relevant documentation and interviewing key eye-witnesses during this joint investigation.

- Substantiate the incident
- Document the medical reports related to the incident
- Interview appropriate people
- Obtain information available to external organizations
- Assess the results.

A case usually starts with a report of a possible chemical incident, usually from a veteran. To substantiate the circumstances surrounding an incident, the investigator searches for documentation from operational, intelligence, and environmental logs. This focuses the investigation on a specific time, date, and location, clarifies the conditions under which the incident occurred, and determines whether there is "hard," as well as anecdotal evidence. Alarms

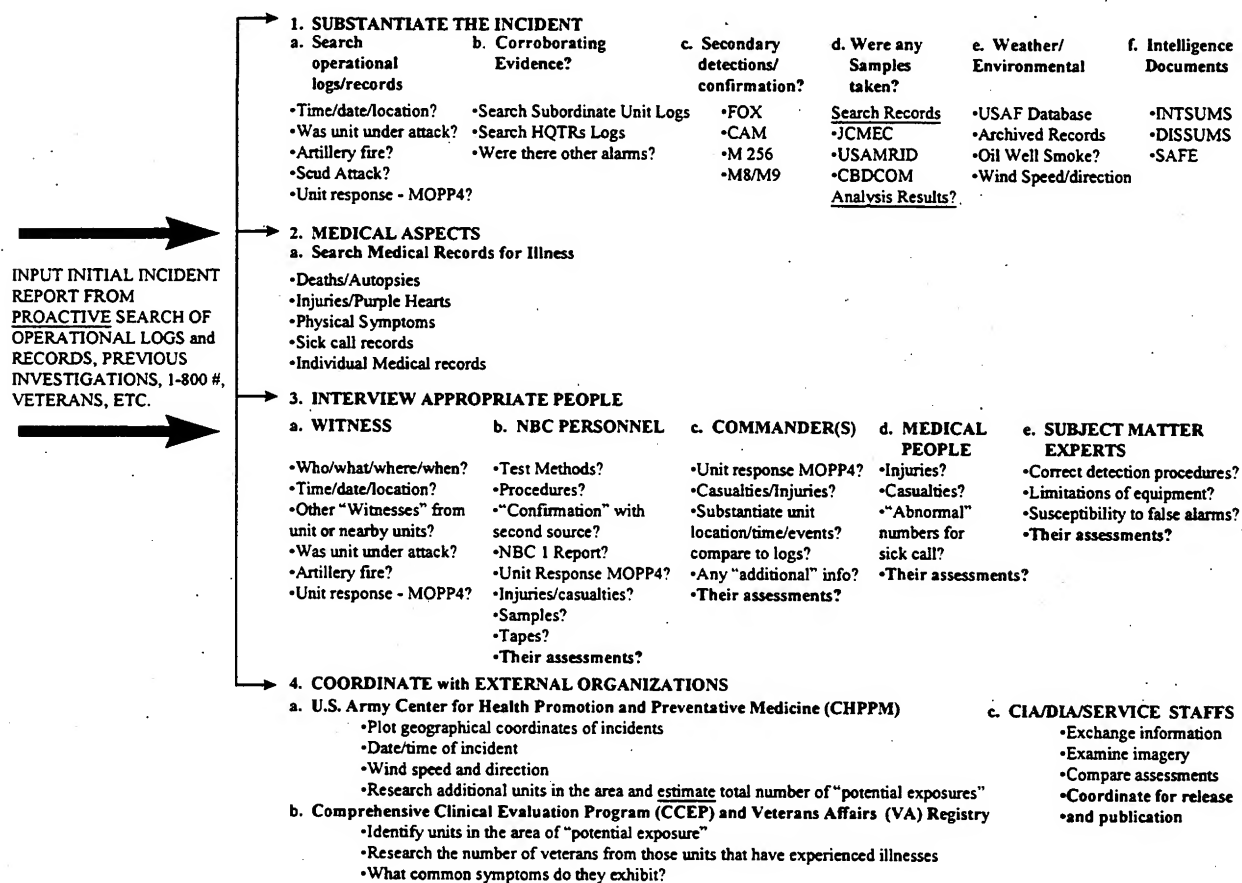


Figure x. Chemical Incident Investigation Methodology

alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence. Additionally, the investigator looks for physical evidence that might indicate that chemical agents were present in the vicinity of the incident, including samples (or the results of analyses of samples) collected at the time of the incident.

The investigator searches the medical records to determine if personnel were injured as a result of the incident. Deaths, injuries, sicknesses, etc. near the time and location of an incident may be telling. Medical experts should provide information about alleged chemical casualties.

Interviews of incident victims (or direct observers) are conducted. First-hand witnesses provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved, and are particularly important if physical evidence is lacking. NBC officers or personnel trained in chemical testing, confirmation, and reporting are interviewed to identify the unit's response, the tests that were run, the injuries sustained, and the reports submitted.

Commanders are contacted to ascertain what they knew, what decisions they made concerning the events surrounding the incident, and their assessment of the incident. Where appropriate, subject matter experts also provide opinions on the capabilities, limitations, and operation of technical equipment, and submit their evaluations of selected topics of interest.

Additionally, the investigator contacts agencies and organizations that may be able to provide additional clarifying information about the case. These would include, but not be limited to:

- Intelligence agencies that might be able to provide insight into events leading to the event, imagery of the area of the incident, and assessments of factors affecting the case
- The DoD and Veterans' clinical registries, which may provide data about the medical condition of personnel involved in the incident.

## ***TAB D - OVERVIEW OF INHIBITED RED FUMING NITRIC ACID AND RELATED HEALTH HAZARDS.***

The following information was extracted directly from a document prepared by the Chemical Propulsion Information Agency titled, Hazards of Chemical Rockets and Propellants, Vol III Liquid Propellants, CPIA Publication Number 394, pp. 15-1 to 15-16, September 1984.

### **Introduction**

Inhibited red fuming nitric acid (IRFNA), known as type IIIB fuming nitric acid in the US, is used as a liquid propellant rocket engine oxidizer. It is light-orange to orange-red in color, clear, strongly fuming, and evolves toxic nitric acid vapor and yellow-red vapors of nitrogen oxides. Fuming nitric acids are unstable releasing nitrogen dioxide, nitric oxide, and nitric acid mist into the atmosphere. Fuming nitric acids are highly corrosive oxidizing agents and will vigorously attack most metals. They also react with many organic materials resulting in spontaneous combustion. IRFNA has the following chemical composition (by weight) and physical properties:

Nitrogen Dioxide (NO <sub>2</sub> )	13-15%
Water (H <sub>2</sub> O)	1.5-2.5%
Nitric Acid (HNO <sub>3</sub> )	81.6-84.8%
Nitrate Solids	.04% max
Hydrogen Flouride Inhibitor	.7%
Boiling Point	337.34 K
Freezing Point	221.15 K
Density (liquid)	1.55 Mg/m <sup>3</sup> at 298.15 K
Vapor Pressure	1.38 kPa at 255.35 K 18.6 kPa at 298.15 K 34.5 kPa at 310.95 K 103.45 kPa at 337.55 K

### **Health Hazards and Symptoms of Exposure**

Toxicity: IRFNA, in contact with any surface of the body (skin, mucous membrane, eyes), destroys tissue by direct contact. It stains the skin or surface into a yellow or yellowish-brown and sustained contact results in a chemical burn. The vapors are highly irritating and toxic to the respiratory tract. Immediately after exposure to dangerous concentrations, there may be coughing, increased respiratory rate, asthmatic-type breathing, nausea, vomiting, and marked fatigue. A fatal pulmonary edema may develop.

Special Medical Information: Exposure to dangerous atmospheric concentrations of the oxides of nitrogen may cause spasm of the terminal bronchioles and disturbances of reflexes causing respiration. Circulatory collapse may ensue, or the symptoms may subside and reappear several hours later with the onset of pulmonary edema. Certain signs indicating that severe lung damage

has occurred may appear within the first few hours. These are an increase in platelets in the venous blood, often as great as 60 to 100 percent, a decrease in blood pressure, and an increase in the hemoglobin content of the blood. Spasmodic cough and dyspnea appearing several hours after the exposure are evidence of the development of pulmonary edema. Bronchopneumonia may be a complication. IRFNA contact with the eyes causes irreparable damage within seconds.

Chronic Exposure: Chronic exposure to low concentrations of the oxides of nitrogen may produce wearing down and decay of the teeth, pulmonary emphysema, and chronic inflammation of the respiratory passages, often with ulceration of the nose or mouth.

### **Exposure Limits**

Threshold Limit Value - Time Weighted Average (TLV®-TWA): A threshold limit value for IRFNA itself has not been established, however the atmospheric threshold limit values for its more toxic components are as follows:

Nitric Acid Mist	2 ppm (5 mg/m <sup>3</sup> )
Nitrogen Dioxide	3 ppm (6 mg/m <sup>3</sup> )
Nitric Oxide	25 ppm (30 mg/m <sup>3</sup> )

Threshold Limit Value - Short Term Exposure Limit (TLV®-STEL) values are as follows:

Nitric Acid Mist	4 ppm (10 mg/m <sup>3</sup> )
Nitrogen Dioxide	5 ppm (10 mg/m <sup>3</sup> )
Nitric Oxide	35 ppm (45 mg/m <sup>3</sup> )

Emergency Exposure limits for Nitrogen Dioxide have been set as follows:

10 minutes at 30 ppm (54 mg/m<sup>3</sup>)  
30 minutes at 20 ppm (36 mg/m<sup>3</sup>)  
60 minutes at 10 ppm (18 mg/m<sup>3</sup>)

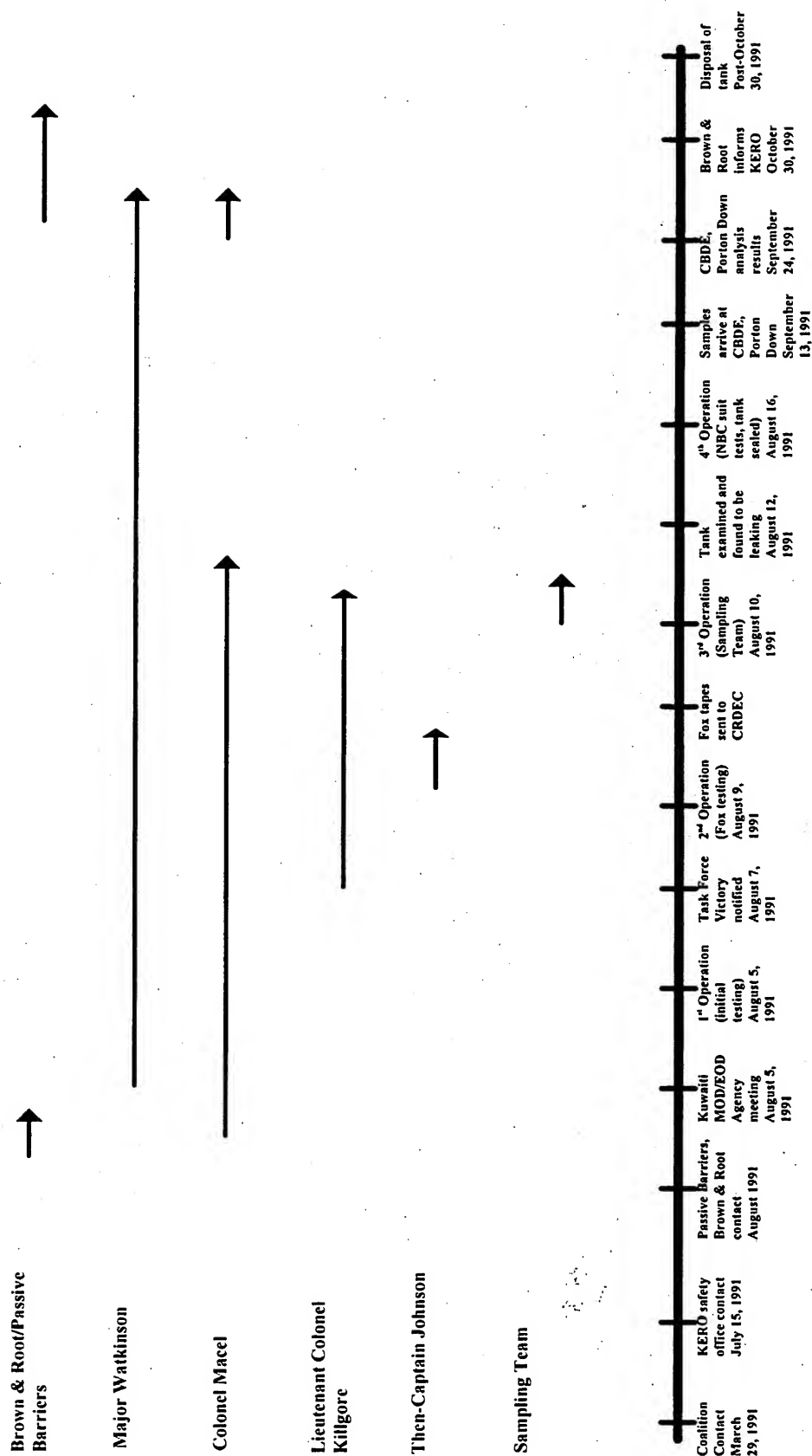
***TAB E - INDIVIDUALS/ORGANIZATIONS INVOLVED  
AND THEIR RESPECTIVE ROLES.***

Participant	Role Played
Safety Officer with the US Army Corps of Engineers, Kuwait Emergency Recovery Office	Early encounter with tank during safety inspection. Recalls vapors being emitted from the tank as smelling like nitric acid.
Passive Barriers	Discovered the tank and notified Brown & Root. Tendered for disposal of the tank.
Brown & Root Supervisor	Notified US Army Corps of Engineers Kuwait Emergency Recovery Office about British subcontractor's discovery of the tank.
Major Watkinson	First to test the tank using four different chemical agent detectors during the first operation. Commanded the first and second operations, present at third operation (resealed tank) and authorized the fourth operation.
Colonel Macel	Briefed 54 <sup>th</sup> Chemical Troop leadership on Fox mission. Was present during the second and third operations.
Lieutenant Colonel Killgore	Present during Fox testing. Took possession of the Fox tapes and faxed them to Aberdeen, MD for analysis. Provided the Sampling Team with a copy of the Fox tapes.
Then-Captain Johnson	Directed the Fox operations during second operation. His report on events served as the focus for public debate in 1996.
Sampling Team Leader	Obtained samples during the third operation which were sent to CBDE, Porton Down, UK for testing and analysis.
Chemical and Biological Defense Establishment (CBDE), Porton Down, UK	Analyzed samples from the third operation provided by the Sampling Team. Concluded that the samples "showed the presence of no material of CW interest."
Chemical Research, Development, and Engineering Center, Aberdeen, MD	Received faxed copy of Fox tapes for analysis. Lost originals and assessment.
Commanding officer of the 146 <sup>th</sup> EOD detachment	Was tasked by the senior EOD officer to inspect the tank and search the site for additional tanks.
Commander of 1 <sup>st</sup> Troop, 21 <sup>st</sup> EOD Squadron	Directed sampling during the second operation.
Commander of 3 <sup>rd</sup> Troop, 21 <sup>st</sup> EOD Squadron	Responsible for final sealing of the tank as well as testing the British MK IV suit during the fourth operation.

**TAB F - MATRIX DEMONSTRATING WHAT EACH PARTICIPANT KNEW ABOUT EVENTS.**

Issue	Brown & Root/Passive Barriers	DRAO/KERO	Major Watkinson	Then-Captain Johnson	Lieutenant Colonel Killgore	Colonel Macel	Sampling Team Leader	Senate Committee/ PACGWVI
Use of school by Iraqis	NO	NO	NO	NO	NO	NO	NO	NO
Knowledge of pre-August 1991 contact	NO	NO	NO	NO	NO	NO	NO	NO
Knowledge of the first operation	NO	NO	YES	YES	YES	YES	YES	YES
Knowledge of the second operation	NO	NO	YES	YES	YES	YES	YES	YES
Saw FOX tapes	NO	NO	NO	NO	YES	NO	YES	NO
Knowledge of the third operation	NO	NO	YES	NO	YES	YES	YES	YES
Knowledge of the fourth operation	NO	NO	YES	NO	NO	NO	NO	NO
Received 1991 CRDEC assessment of Fox tapes	NO	NO	NO	NO	NO	NO	NO	NO
Aware of the results of CBDE, Porton Down analysis	YES	YES, via Brown & Root	YES	NO	NO	YES	YES	YES, via 1994 letter from MOD to DoD
Knowledge of how the tank was disposed	NO	NO	NO	NO	NO	NO	NO	NO
Saw final report on events	NO	NO	NO	NO	NO	NO	NO	NO

**TAB G - TIMELINE RELATING EVENTS AND WHO WAS INVOLVED.**





# TAB H - FOX MASS SPECTROMETER PRINTOUTS FROM TESTING.

14-00000-10140

PAGE 1001

UNCLASSIFIED

1997231-0000063

1 of 14

~~SECRET~~

TO: CRDEC (ATTN. RICHARD VIGAS)  
BLDG # 3549  
ROOM # C312  
COM. FAX 301-671-3807

DECLASSIFIED

ON: 30 SEP 97

BY: SEC. ARMY (DAMH)

UNDER SEC 34 EC 12958

SUBJECT: SUBSTANCE SAMPLING (9 AUG 91) KUWAIT

1. SAMPLE FROM INDUSTRIAL TYPE TANK (SEE PG 3 OF 14)

2. TEMPERATURE - 110°F WINDSPEED - APPX. 25 KNOTS

3. SCHEMATIC OF TANK (SEE PG 4 OF 14).


4. PREVIOUS FIELD TESTS BY BRITISH:

- a. CAM - 8 BARS FOR H (No G).
- b. MB PAPER (VAPOR) - PINK COLOR - H
- c. LIQUID ON M9 PAPER - BROWN COLOR - H
- d. LIQUID ON MB PAPER - PINK COLOR - H
- e. M18A2 KT - 6 SAMPLES, 4 SAMPLES - BLUE COLOR, 2 SAMPLES - NO COLOR.

5. SAMPLING PROCEDURE (SEE SKETCH PG 5 OF 14).

a. BRITISH SOLDIER OBTAINED LIQUID SAMPLE FROM BULLET HOLE (PREVIOUSLY SEALED) AT 1. SAMPLE WAS PLACED IN METAL PAN.

b. SAMPLE WAS CARRIED TO POSITION 2 WHERE C-23 OPERATOR PLACED PAN TO PROBE.

  
c. SAMPLE WAS THEN CARRIED TO C-26 WHERE C-26 OPERATOR PLACED PAN TO PROBE.

d. MM1'S ANALYZED SAMPLES.

6. OBSERVATIONS:

a. WHEN BULLET HOLE WAS OPENED, SIGNIFICANT VAPOR ESCAPED. VAPOR WAS BROWN IN COLOR AND WAS READILY EVIDENT FROM CONTROL POINT (APPX 100M).

b. SUBSTANCE WAS EXTREMELY VOLATILE.


c. TIME FROM POS. 1 IN SAMPLING PROCEDURE TO POS. 3 WAS APPX. 25 MINUTES.

d. MM1 STRIPCHARTS ARE AT PG <sup>14</sup>~~6~~ OF <sup>14</sup>~~6~~ THRU PG <sup>14</sup>~~6~~ OF <sup>14</sup>~~6~~.

e. TWO SAMPLES WERE ANALYZED PER FOX. IN FOLLOWING SEQUENCE: C-23, C-26, C-23, C-26.

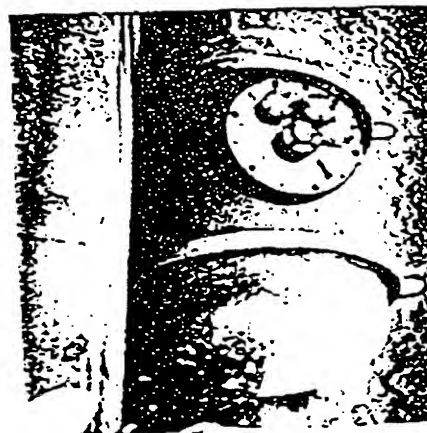
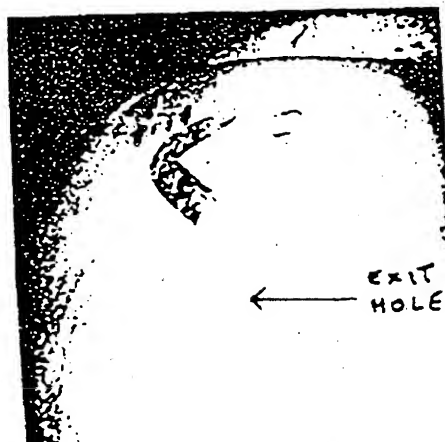
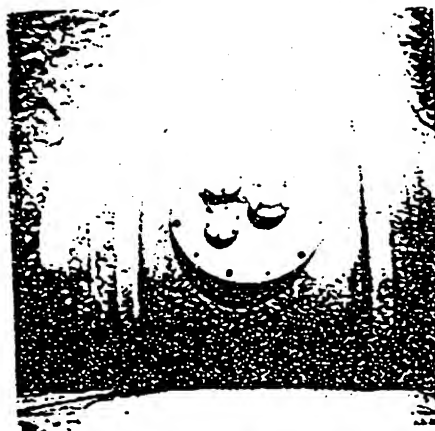
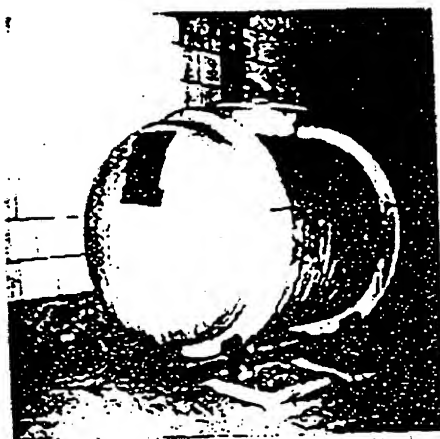
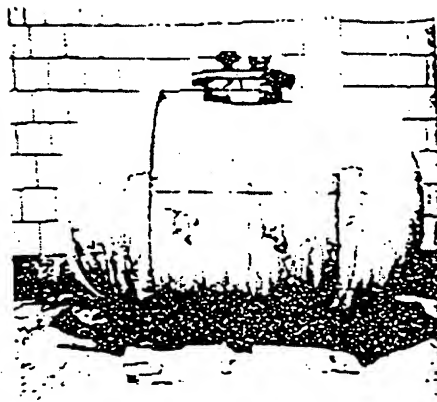
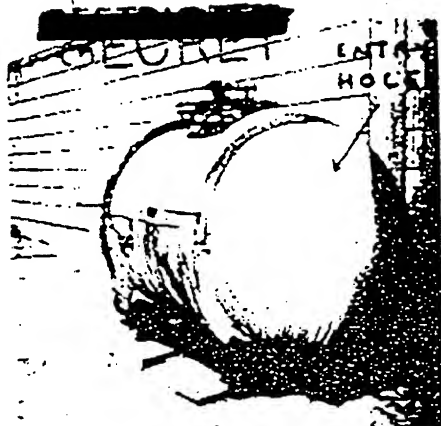
f. DIFFERENCES IN SPECTRA MAY BE DUE TO VAPORATION RATE.

7. SORRY ABOUT PRINTING!

  
DON W. KILGORE  
LTC, GS  
COFS TF VICTORY  
(3ID CNL OFFICER).  
318-791-5056

14 AUG 1971 11241

FORM 1000



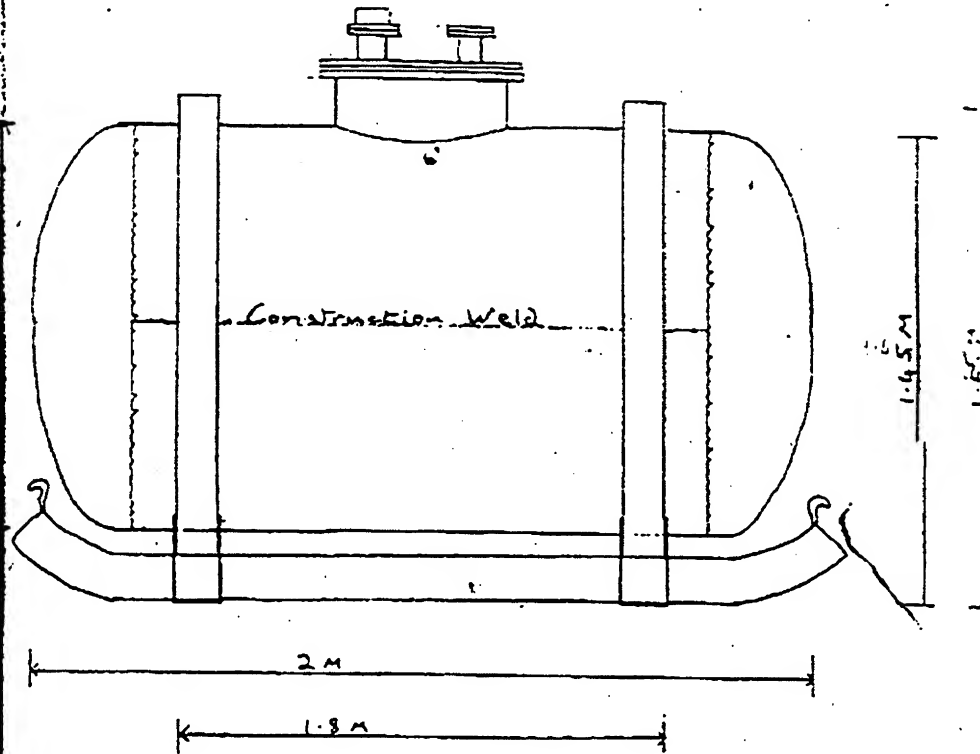
FROM BRITS

14

DATED 07 AUG 69

BEING SAVING DIMENSIONS

90mm  
K K



~~SECRET~~

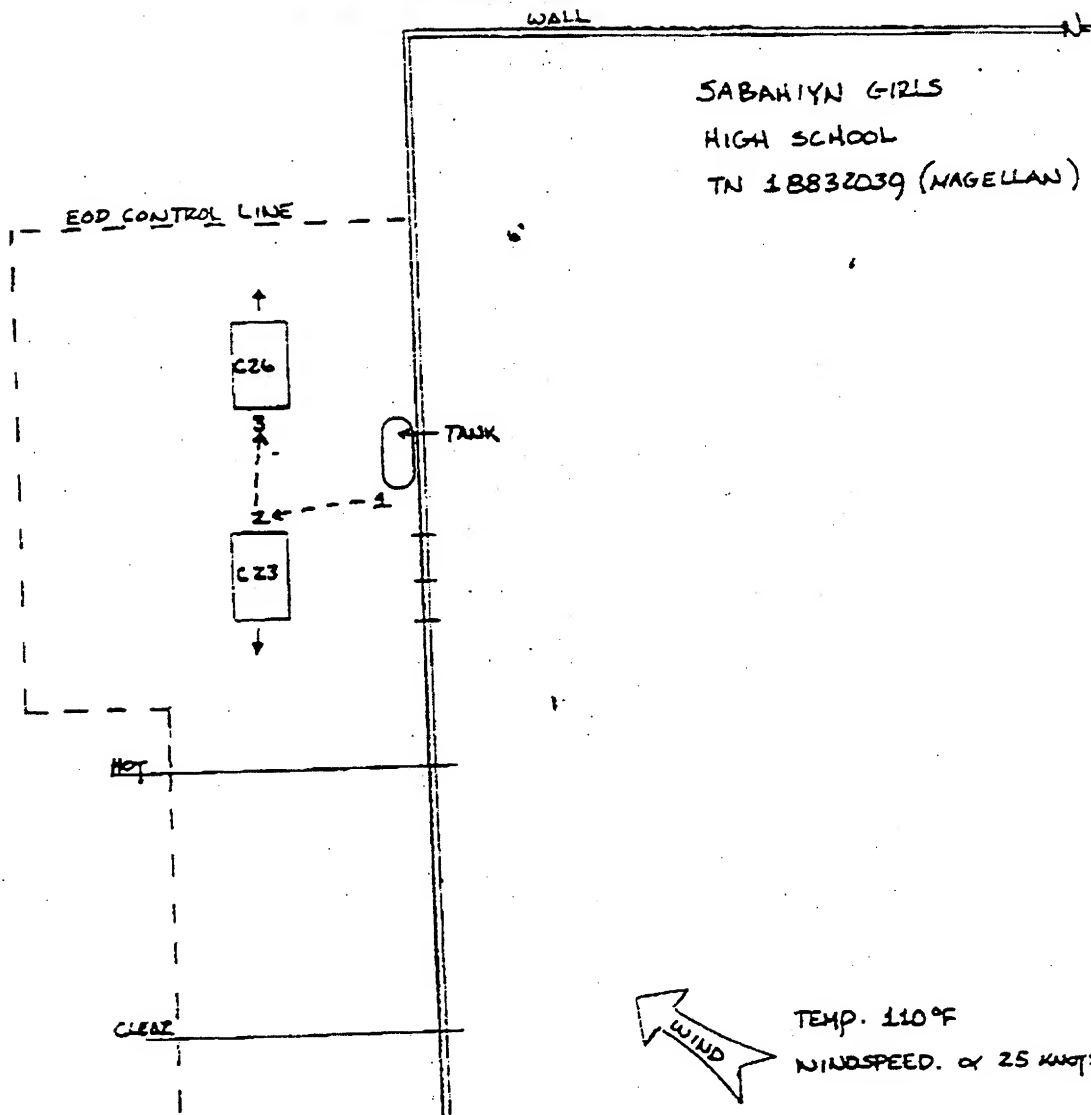
MANAGEMENT IN CONFIDENCE

RESTRICTED

FROM BRITS.

SITE LAYOUT

50F  $\frac{14}{14}$



FUNCTION TESTS  
09/08/91 11:28

AUTOMATIC TEST OK

REPORT HEADING  
09/08/91 12:37

COMMANDER  
SGT. TUCKER

ORDER  
MISSION

OPERATOR  
SGT. MYERS

REGION  
KWAIT

AIR MONITOR

\* 150 2  
PHOSGENE (CG) C 3.6

12:50 2  
PHOSGENE (CG) C 3.6

12:51 3  
SPECTRUM  
UNKNOWN S 5.9

SPECTRA  
09/08/91 13:01

SPECTRUM NO 2

M	MASS	INTENS.
1	46	100.0%
2	47	11.0%
3	48	3.5%
4	49	0.9%
5	50	3.4%
6	51	3.6%

7	52	1.7%
8	53	2.5%
9	54	2.5%
10	55	7.2%
11	56	7.4%
12	57	13.6%
13	58	2.4%
14	59	2.7%
15	60	4.5%
16	61	1.6%
17	62	0.8%
18	63	1.9%
19	64	3.9%
20	65	1.2%
21	66	0.8%
22	67	1.2%
23	68	0.6%
24	69	3.4%
25	70	1.0%
26	71	0.9%
27	72	1.9%
28	73	15.4%
29	74	2.1%
30	75	2.0%
31	76	2.9%
32	77	5.6%
33	78	1.5%
34	79	5.3%
35	80	0.3%
36	81	0.9%
37	82	0.9%
38	83	0.8%
43	88	0.5%
44	89	0.9%
45	90	0.4%
46	91	3.1%
47	92	0.5%
49	94	0.6%
50	95	0.4%
51	96	2.6%
52	97	0.9%
53	98	0.3%
57	102	0.5%
58	103	0.9%
59	104	0.8%
60	105	3.1%
61	106	1.0%
62	107	0.5%
63	108	0.6%
65	110	0.1%

67	112	0.3%
69	114	0.3%
70	115	0.9%
71	116	0.5%
72	117	0.8%
73	118	0.7%
74	119	1.6%
75	120	0.6%
76	121	0.6%
77	122	2.0%
78	123	0.3%
79	124	0.3%
80	125	0.4%
81	126	0.2%
82	127	0.3%
83	128	0.3%
84	129	0.5%
85	130	0.2%
86	131	1.0%
87	132	0.4%
88	133	3.4%
89	134	0.9%
90	135	1.1%
91	136	0.4%
92	137	0.3%
93	138	0.2%
94	139	0.2%
95	140	0.2%
96	141	0.3%
97	142	0.1%
98	143	0.2%
99	144	0.1%
100	145	0.3%
101	146	0.3%
102	147	1.7%
103	148	0.4%
105	150	0.1%
106	151	1.3%
107	152	0.5%
109	153	1.2%
109	154	0.6%
110	155	1.9%
111	156	0.3%
112	157	0.8%
113	159	0.4%
114	161	0.5%
115	162	0.3%
116	163	1.0%
117	164	0.3%
118	165	0.5%

~~SECRET~~

14 AUG 1991 11:55

PAGE 003

VEHICLE C-23 -2

70F-14

121 175	0.2%
122 176	0.4%
123 177	1.1%
124 178	0.4%
125 179	0.7%
126 180	0.4%
127 181	0.1%
128 182	0.3%
129 183	0.2%
130 184	0.2%
131 185	0.2%
132 186	0.2%
133 189	0.2%
134 190	0.3%
135 191	2.2%
136 192	0.7%
137 193	2.4%
138 194	0.6%
139 195	0.4%
140 196	0.2%
141 203	0.2%
142 205	0.4%
143 206	0.4%
144 207	14.1%
145 208	3.9%
146 209	2.7%
147 210	1.1%
148 211	0.7%
149 212	0.8%
150 213	0.3%
151 214	0.4%
152 216	0.2%
153 218	0.2%
154 219	0.3%
155 221	0.3%
156 222	0.2%
157 223	0.2%
158 235	0.2%
159 237	0.2%
160 243	0.3%
161 244	0.2%
162 245	0.5%
163 246	0.3%
164 247	0.8%
165 248	0.2%
166 249	0.9%
167 250	0.3%
168 251	0.7%
169 252	0.2%

170 253	1.0%
171 264	0.2%
172 265	0.6%
173 266	0.4%
174 267	1.6%
175 269	0.9%
176 269	0.6%
177 270	0.2%
178 281	2.8%
179 282	1.7%
180 283	0.8%
181 284	0.3%
182 285	0.2%
183 325	0.1%
184 327	0.1%
185 341	0.2%
186 342	0.2%

TEMPERATURE = 121  
100% INTENS. = 5.9

BACKGROUND  
V CHA SURFACE/LO

AIR MONITOR

13:22 4  
PHOSGENE (CG) C 3.1

13:23 5  
SPECTRUM  
UNKNOWN S 7.6

SPECTRUM  
09/08/91 13:23

1 46 100.0%  
28 73 3.4%

13:25 6  
SPECTRUM  
UNKNOWN S 5.0

SPECTRUM  
09/08/91 13:26

1 46 100.0%  
2 47 4.7%  
28 73 8.4%  
34 79 5.7%  
40 85 3.4%  
129 207 5.3%

SPECTRA  
09/08/91 13:27

SPECTRUM NO 2

N	MASS	INTENS.
1	46	100.0%
2	47	11.0%
3	48	2.5%
4	49	0.9%
5	50	3.4%
6	51	3.6%
7	52	1.7%
8	53	2.5%
9	54	2.5%
10	55	7.2%
11	56	7.4%
12	57	13.6%
13	58	0.4%
14	59	2.7%
15	60	4.5%
16	61	1.6%
17	62	0.8%
18	63	1.9%
19	64	3.9%
20	65	1.2%
21	66	0.9%

# VEHICLE C-23 - 3

8 of 14

22	67	1.2%	83	128	0.3%	135	191	2.2%
23	68	0.6%	84	129	0.5%	136	192	0.7%
24	69	3.4%	85	130	0.2%	137	193	2.4%
25	70	1.0%	86	131	1.0%	138	194	0.6%
26	71	0.9%	87	132	0.4%	139	195	0.4%
27	72	1.9%	88	133	3.4%	140	196	0.2%
28	73	15.4%	89	134	0.9%	141	203	0.2%
29	74	2.4%	90	135	1.1%	142	205	0.4%
30	75	2.8%	91	136	0.4%	143	206	0.4%
31	76	1.9%	92	137	0.3%	144	207	14.1%
32	77	6.6%	93	138	0.2%	145	208	3.9%
33	78	1.5%	94	139	0.2%	146	209	2.7%
34	79	5.3%	95	140	0.2%	147	210	1.1%
35	80	0.8%	96	141	0.3%	148	211	0.7%
36	81	0.9%	97	142	0.1%	149	212	0.8%
37	82	0.9%	98	143	0.2%	150	213	0.3%
38	83	0.8%	99	144	0.1%	151	214	0.4%
43	88	0.5%	100	145	0.3%	152	216	0.2%
44	89	0.3%	101	146	0.3%	153	218	0.2%
45	90	0.4%	102	147	1.7%	154	219	0.3%
46	91	3.1%	103	148	0.4%	155	221	0.3%
47	92	0.5%	105	150	0.1%	156	222	0.2%
49	94	0.6%	106	151	1.3%	157	223	0.2%
50	95	0.4%	107	152	0.5%	158	235	0.2%
51	96	2.6%	108	153	1.2%	159	237	0.2%
52	97	0.9%	109	154	0.6%	160	243	0.3%
53	98	0.3%	110	155	1.9%	161	244	0.2%
57	102	0.5%	111	156	0.3%	162	245	0.5%
58	103	0.9%	112	157	0.8%	163	246	0.3%
59	104	0.8%	113	159	0.4%	164	247	0.8%
60	105	0.1%	114	161	0.5%	165	248	0.2%
61	106	1.8%	115	162	0.3%	166	249	0.9%
62	107	0.5%	116	163	1.0%	167	250	0.3%
63	108	0.6%	117	164	0.3%	168	251	0.7%
65	110	0.1%	118	165	0.5%	169	252	0.2%
67	112	0.3%	119	166	0.2%	170	253	0.3%
69	114	0.3%	121	175	0.2%	171	264	0.2%
70	115	0.9%	122	176	0.4%	172	265	0.6%
71	116	0.8%	123	177	1.1%	173	266	0.4%
72	117	0.8%	124	178	0.4%	174	267	1.6%
73	118	0.7%	125	179	0.7%	175	268	0.8%
74	119	1.6%	126	180	0.4%	176	269	0.6%
75	120	0.6%	127	181	0.1%	177	270	0.2%
76	121	0.6%	128	182	0.3%	178	281	3.6%
77	122	2.8%	129	183	0.2%	179	282	1.7%
78	123	0.3%	130	184	0.2%	180	283	0.8%
79	124	0.3%	131	186	0.2%	181	284	0.3%
80	125	0.4%	132	188	0.2%	182	285	0.2%
81	126	0.2%	133	189	0.2%	183	325	0.1%
			134	190	0.3%	184	327	0.1%

14 406 197 11:57

PAGE 005



VEHICLE C23 -4

9 of 14

185 341 0.2%  
186 342 0.2%

TEMPERATURE = 121  
100% INTENS. = 5.9

SPECTRA  
09/08/91 13:29

SPECTRUM NO 3

N	MASS	INTENS.
1	46	100.0%
2	47	2.6%
3	48	0.2%
4	49	0.1%
5	50	0.5%
6	51	0.5%
7	52	0.2%
8	53	0.3%
9	54	0.3%
10	55	1.0%
11	56	0.7%
12	57	1.7%
13	58	0.2%
14	59	0.4%
15	60	0.6%
16	61	0.2%
18	63	1.7%
19	64	0.5%
20	65	0.2%
21	66	0.1%
22	67	0.2%
23	68	0.1%
24	69	0.3%
25	70	0.2%
26	71	0.2%
27	72	0.1%
28	73	3.4%
29	74	0.4%
30	75	0.3%
31	76	0.2%
32	77	0.8%
33	78	0.2%
34	79	1.3%
35	80	0.1%
36	81	0.2%
37	82	0.1%

38	83	0.2%
40	85	0.2%
42	87	0.2%
44	89	0.1%
45	91	0.3%
51	96	0.3%
52	97	0.2%
53	103	0.1%
59	104	0.1%
60	105	0.5%
70	115	0.2%
72	117	0.1%
74	119	0.2%
77	122	0.3%
88	133	0.4%
90	135	0.2%
102	147	0.3%
106	151	0.1%
108	153	0.2%
110	155	0.2%
113	163	0.2%
132	177	0.1%
134	179	0.1%
146	191	0.3%
148	193	0.3%
162	207	1.6%
163	208	0.5%
164	209	0.3%
165	210	0.1%
204	249	0.1%
222	267	0.3%
223	268	0.1%
235	281	0.4%
236	282	0.2%
237	283	0.1%

TEMPERATURE = 121  
100% INTENS. = 7.6

SPECTRA  
09/08/91 13:30

SPECTRUM NO 4

N	MASS	INTENS.
1	46	100.0%
2	47	4.7%
3	48	1.6%

4	49	0.6%
5	50	2.3%
6	51	1.4%
7	52	1.1%
8	53	0.9%
9	54	1.1%
10	55	2.7%
11	56	2.1%
12	57	2.7%
13	58	1.2%
14	59	1.3%
15	60	1.1%
16	61	0.9%
17	62	0.4%
18	63	1.5%
19	64	2.3%
20	65	0.8%
21	66	0.6%
22	67	0.5%
25	70	0.5%
26	71	0.3%
27	72	1.3%
28	73	8.4%
29	74	1.3%
30	75	0.9%
31	76	0.9%
32	77	1.6%
33	78	0.9%
34	79	5.7%
35	80	0.6%
36	81	0.6%
37	82	0.4%
38	83	0.3%
40	85	3.4%
42	87	1.8%
43	88	0.2%
44	89	0.5%
45	90	0.3%
46	91	2.3%
47	92	0.3%
49	94	0.3%
51	96	1.0%
52	97	0.3%
56	101	0.3%
57	102	0.3%
58	103	0.8%
60	105	1.0%
61	106	0.8%
62	107	0.2%
63	108	0.3%

14 000 197 10115

TOTAL PAGE.001  
PAGE.001

# VEHICLE C23 -5

10.7.14

69 114	0.1%
70 115	0.5%
71 116	0.2%
72 117	0.5%
73 118	0.4%
74 119	0.5%
75 120	0.2%
76 121	0.1%
77 122	0.3%
79 124	0.2%
80 125	0.1%
81 126	0.1%
82 127	0.1%
83 128	0.2%
84 129	0.2%
85 130	0.1%
87 132	0.2%
88 133	1.2%
89 134	0.4%
90 135	0.4%
91 136	0.1%
92 137	0.2%
93 138	0.1%
94 139	0.1%
95 141	0.2%
96 145	0.2%
97 146	0.2%
98 147	0.9%
99 148	0.2%
102 151	0.1%
103 152	0.1%
104 153	0.2%
105 154	0.2%
106 155	0.2%
107 157	0.1%
108 161	0.2%
109 162	0.1%
110 163	0.4%
111 164	0.1%
112 165	0.2%
113 166	0.1%
114 176	0.1%
115 177	0.5%
116 178	0.2%
117 179	0.3%
118 180	0.3%
119 182	0.2%
120 184	0.1%
121 189	0.1%
122 191	1.0%

123 192	0.3%
124 193	0.9%
125 194	0.2%
126 195	0.2%
127 205	0.2%
128 206	0.1%
129 207	5.3%
130 208	1.6%
131 209	0.5%
132 210	0.2%
133 211	0.2%
134 212	0.1%
135 221	0.2%
136 222	0.1%
137 223	0.1%
138 249	0.3%
139 250	0.1%
140 251	0.3%
141 252	0.1%
142 253	0.1%
143 265	0.4%
144 266	0.2%
145 267	0.9%
146 268	0.3%
147 269	0.3%
148 281	2.3%
149 282	1.2%
150 283	0.6%
151 284	0.2%
152 285	0.1%
153 327	0.1%
154 341	0.1%
155 342	0.1%

TEMPERATURE = 121  
100% INTENS. = 6.0

BACKGROUND  
V CHA SURFACE/LO

AIR MONITOR

7450/2747 13:37 7  
EXTRA SUBST.A2 C 3.1

\*K 13:38 8  
EXTRA SUBST.A2 C 3.5

14-000 37 11:52

PAGE 008

VEHICLE C-26 -1

110p

~~SECRET~~

BACKGROUND  
V CWA WHEEL/HI

CALIBRATED

BACKGROUND  
V CWA WHEEL/HI

REPORT HEADING  
08/09/91 12:29

COMMANDER:  
LT BANCHS  
ORDER  
PT. RECON  
OPERATOR:  
SGT. PESTANA  
REGION  
KTO

TEMP: 110  
WIN/DIR: F NW TO SE  
NIS: ID OR DENY  
SUSP. AGT

AIR MONITOR  
08/09/91 12:29

V CWA WHEEL/HI  
CODE  
A TABUN (GA) 1  
B SARIN (GB) 1  
C SOMAN (GD) 1  
D VX (VX) 1  
E S-MUSTARD (HD) 1  
F LEWISITE (L) 1  
G PHOSGENE (CG) 1  
H HCN (AC) 1  
I FAT, OIL, WAX 1

BACKGROUND  
CWA SURFACE/LO

AIR MONITOR  
08/09/91 12:31

V CWA SURFACE/LO  
CODE  
A TABUN (GA) 1  
B SARIN (GB) 1  
C SOMAN (GD) 1  
D VX (VX) 1  
E S-MUSTARD (HD) 1  
F LEWISITE (L) 1  
G PHOSGENE (CG) 1  
H HCN (AC) 1  
I FAT, OIL, WAX 1

BACKGROUND  
V CWA SURFACE/LO

0162/2041 12:51 3  
SPECTRUM  
UNKNOWN S 5.5

SPECTRUM  
06/09/91 12:51

1 46 62.3%  
2 47 7.9%  
3 48 6.6%  
5 50 3.4%  
6 51 7.8%  
7 52 5.2%  
8 53 7.5%  
9 54 9.2%

10 55 24.2%  
11 56 18.2%  
12 57 22.5%  
13 58 7.1%  
14 59 6.7%  
15 60 8.3%  
19 64 3.4%  
20 65 3.5%  
22 67 5.7%  
23 68 3.8%  
24 69 100.0%  
25 70 5.6%  
26 71 3.4%  
27 72 6.5%  
28 73 8.8%  
29 74 3.8%  
30 75 3.0%  
31 76 9.3%  
32 77 9.6%  
33 78 3.5%  
34 79 4.7%  
36 81 3.4%  
37 82 4.2%  
38 83 5.0%  
40 85 9.8%  
42 87 5.1%  
46 91 10.5%  
51 96 3.6%  
55 100 9.4%  
60 105 5.6%  
61 106 4.1%  
69 114 3.6%  
74 119 9.7%  
83 131 31.3%  
119 207 8.6%  
125 219 17.1%  
129 264 4.5%

14 438 140 10000

PAGE 001

VEHICLE C-26-2

12:00  
14

AIR MONITOR  
08/09/91 12:52

V CWA SURFACE/LO

CODE	1
A TABUN (GA)	1
S SARIN (GB)	1
C SOMAN (GD)	1
D VX (VX)	1
E S-MUSTARD (HD)	1
F LEWISITE (L)	1
G PHOSGENE (CG)	1
H HCN (AC)	1
I FAT.OIL/WAX	1
J EXTRA SUBST.A1	1

BACKGROUND  
V CWA SURFACE/LO

AIR MONITOR

12:53 4  
PHOSGENE (CG) C 3.9  
EXTRA SUBST.A1 C 5.1

12:53 5  
EXTRA SUBST.A1 C 5.1

12:54 6  
EXTRA SUBST.A1 C 5.1

12:54 7  
EXTRA SUBST.A1 C 5.1

12:55 8  
EXTRA SUBST.A1 C 5.1

12:55 9  
EXTRA SUBST.A1 C 5.0

12:56 10  
EXTRA SUBST.A1 C 4.9

12:56 11  
EXTRA SUBST.A1 C 5.0

12:57 12  
EXTRA SUBST.A1 C 5.0

12:57 13  
EXTRA SUBST.A1 C 5.0

12:58 14  
EXTRA SUBST.A1 C 5.0

12:58 15  
EXTRA SUBST.A1 C 5.0

12:59 16  
EXTRA SUBST.A1 C 5.1

12:59 17  
PHOSGENE (CG) C 3.9  
EXTRA SUBST.A1 C 5.1

13:00 18  
PHOSGENE (CG) D 4.0  
EXTRA SUBST.A1 C 5.1

13:00 19  
SPECTRUM  
UNKNOWN S 6.0

SPECTRUM  
08/09/91 13:01

1	46	100.0%
2	47	5.7%
3	48	3.6%
9	54	3.1%
10	55	3.6%
11	56	5.4%
12	57	7.1%
19	64	3.9%
24	69	28.9%
28	73	3.7%
32	77	3.8%
46	91	3.3%
86	131	9.5%
137	219	4.6%

AIR MONITOR  
08/09/91 13:02

V CWA SURFACE/LO

CODE	1
A TABUN (GA)	1
S SARIN (GB)	1
C SOMAN (GD)	1
D VX (VX)	1
E S-MUSTARD (HD)	1
F LEWISITE (L)	1
G PHOSGENE (CG)	1
H HCN (AC)	1
I FAT.OIL/WAX	1
J EXTRA SUBST.A1	1
K EXTRA SUBST.A2	1

BACKGROUND  
V CWA SURFACE/LO

AIR MONITOR

13:02 20  
S-MUSTARD (HD) C 3.6  
EXTRA SUBST.A1 C 5.1  
EXTRA SUBST.A2 C 5.7  
PHOSGENE (CG) C 4.3

13:03 21  
S-MUSTARD (HD) C 3.6  
EXTRA SUBST.A1 C 5.1  
EXTRA SUBST.A2 C 5.6  
PHOSGENE (CG) C 4.2

13:03 22  
EXTRA SUBST.A1 C 5.1  
EXTRA SUBST.A2 C 5.6  
PHOSGENE (CG) C 4.4

13:04 23  
EXTRA SUBST.A2 C 5.4  
EXTRA SUBST.A1 C 4.9  
PHOSGENE (CG) C 4.5

14 AUG 1991 11:59

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VEHICLE C-26 - 3

13 of 14

~~SECRET~~

13:04 24  
EXTRA SUBST.A2 C 5.4  
EXTRA SUBST.A1 C 4.9  
PHOSGENE (CG) C 4.3

13:05 25  
EXTRA SUBST.A2 C 5.4  
EXTRA SUBST.A1 C 4.9

13:05 26  
EXTRA SUBST.A2 C 5.2  
EXTRA SUBST.A1 C 4.9

13:06 27  
EXTRA SUBST.A2 C 5.0  
EXTRA SUBST.A1 C 4.9

13:06 28  
EXTRA SUBST.A1 C 4.9

AIR MONITOR  
08/09/91 13:09

V CWA SURFACE/LO  
CODE  
A S-MUSTARD (HD) 1  
B PHOSGENE (CG) 1  
C FAT,OIL,WAX 1

BACKGROUND  
V CWA SURFACE/LO

AIR MONITOR

13:09 29  
PHOSGENE (CG) C 3.9

13:09 30  
PHOSGENE (CG) C 3.9

13:30 31  
SPECTRUM  
EXTRA SUBST.A2 S 5.9

SPECTRUM  
08/09/91 13:30

1 46 100.0%  
2 47 6.8%  
10 55 7.7%  
11 56 3.6%  
12 57 5.5%  
24 69 22.3%  
28 73 3.1%  
32 77 3.0%  
34 79 3.3%  
40 85 3.2%  
46 91 3.6%  
94 131 6.4%  
121 219 3.3%

AIR MONITOR

13:31 32  
PHOSGENE (CG) C 3.7

13:32 33  
SPECTRUM  
UNKNOWN S 6.7

13:32 34  
PHOSGENE (CG) C 4.1

13:32 35  
PHOSGENE (CG) C 4.1

13:33 36  
PHOSGENE (CG) C 4.1

13:33 37  
SPECTRUM  
UNKNOWN S 7.4

SPECTRUM  
08/09/91 13:34

1 46 100.0%

AIR MONITOR

13:34 38  
S-MUSTARD (HD) C 4.1  
FAT,OIL,WAX C 5.1

13:34 39  
S-MUSTARD (HD) C 4.1  
FAT,OIL,WAX C 5.1

13:35 40  
S-MUSTARD (HD) C 3.8

13:35 41  
S-MUSTARD (HD) C 3.8

13:36 42  
PHOSGENE (CG) C 4.3

13:36 43  
PHOSGENE (CG) C 4.3

13:37 44  
PHOSGENE (CG) C 4.3

13:37 45  
PHOSGENE (CG) C 4.0

13:38 46  
PHOSGENE (CG) C 4.1

13:39 47  
SPECTRUM  
EXTRA SUBST.A2 S 5.9

~~SECRET~~

~~CONFIDENTIAL~~

08/09/91 13:39

1	46	100.0%
2	47	5.0%
10	55	7.8%
11	56	4.1%
12	57	6.7%
24	69	30.7%
23	73	4.9%
34	79	5.8%
40	85	3.3%
46	91	4.4%
55	100	3.2%
74	119	3.1%
86	131	9.9%
123	207	3.1%
127	219	5.3%

~~CONFIDENTIAL~~

14 AUG 197 12:00

\*\*\* TOTAL PAGE.010 \*\*\*  
PAGE.010

## TAB I - EXPLANATION OF SIBCA KIT

DECLASSIFIED

ANNEX A  
GAMUT 10-C/A/005/92/MT  
CDE GAMUT Report G40  
DATE 0 FEB 93

### THE SIBCA SAMPLING KIT

CMAT Control #  
1998055-0000014

#### Concept of the Kit

The requirement was for a kit suitable for use in the battlefield for taking a wide variety of samples that may contain CW or BW agents. The design criteria were:

- a. The kits were to be used by service personnel who would be briefed on SIBCA but who would otherwise be unfamiliar with the concept or practice of chemical or biological sampling. They would therefore need to be simple to use and would need to contain full instructions.
- b. Equipment for the safe collection and packaging of toxic samples would need to be provided.
- c. The collection and packaging of samples would be performed by personnel wearing full IPE.
- d. The original concept was that the kit would be used only for CW agents although the requirement was later extended to include BW.
- e. The kits should be light in weight and easily portable but contain sufficient equipment for several sample missions.
- f. The kits were for immediate deployment in the field and therefore had to be constructed from readily available components.
- g. The kits would need to be sufficiently rugged for field use although there would be no time to acquire special components or carry out extensive tests.
- h. Information sheets would be included in the kit so that the crucial observations from the battlefield could be recorded and be available with the sample for assessment.

#### Kit Design

The design was based on an existing sampling kit that had been constructed for use by CBDE scientists for the collection of samples of CW agents, air, soil, water and other materials from old WWII CW production and storage sites

DECLASSIFIED

RESTRICTED CANUKUS EYES ONLY  
**DECLASSIFIED**

that still exist in UK. The design was modified to include the experience of other NATO countries in constructing sampling kits for SIBCA operations (2). Many of these kits contain apparatus to carry out preliminary extractions of the samples in the field and/or equipment to refrigerate samples to preserve the intact agent for extended periods. However, since the concept of SIBCA operations in the Gulf was rapidly to transport the samples to CBDE in typically 24 hours, these approaches were not included in order to keep the equipment and operation as simple as possible.

#### Kit Construction

The sampling kits were packaged in rigid anodised aluminium faced carrying cases size 458 x 341 x 145 mm, sold as photographic or instrument carrying cases (see photograph). The foam plastic inserts supplied with each case were discarded except for a 20 mm thick sheet lining the lid which assisted in keeping the contents from undue movement.

The packed cases were supplied to the users unlocked and without keys.

Before dispatch from CDE the cases were secured by tough plastic banding tape fixed with metal crimp tags.

Each item, set or pack were bagged separately in sealed lay-flat polythene tubing to keep similar items together and reduce movement.

#### Contents List of Current Kit

Suppliers and Part Nos are listed in Appendix 1.

<u>Item</u>	<u>No</u>
1 Instructions and Information forms (see Appendices 2 and 3)	1 set
2 NBC Gloves + Cotton Innings	2 sets
3 Plastic Scoops Large and Small	1 of each
4 Tongs, Small Scissors, Spatulas (2)	1 set
5 Large Scissors	1
6 Chisel	1
7 Knife with replaceable blades	1
8 Syringes and Needles	2
9 Butyl Rubber Tubing	1 x 3m
10 Plastic Pipettes	5
11 Plastic Sample Bags	4 x 36" x 24" 20 x 12" x 8"

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18



RESTRICTED DATA - EYES ONLY  
**DECLASSIFIED**

<u>Item</u>	<u>No</u>
12 Sample Bottles	4 x 100g 4 x 50g 8 x 15g 4 x 5g
13 Vapour Sampling Tubes (Tenax) + Plastic Bags for Transportation	16
14 Vapour Sampling Pump + spare PP3 batteries and screwdriver	1
15 Swab Kit (Cotton Wool, Isopropanol, Tweezers)	1
16 Fullers Earth	1 Pack
17 Charcoal	2 Packs
18 Adhesive Tape	1 Roll
19 Tissues	1 Box
20 "VERY TOXIC" stick-on labels	10
21 Tie-on labels with string	10
22 Sample Transit Bags	4
23 Note Book, Marker and Pen	1 of each

#### Notes on Kit Contents

These notes should be read in conjunction with the "Use of Kit Instructions". See also Photographs. Over the period of GRANBY, the kit design evolved to incorporate new concepts. The contents described are contained in the latest version.

#### Scissors

The large scissors in each kit were left unpackaged to enable NBC gloved personnel to open easily other items sealed in plastic bags.

#### Vapour Sampling Pump and Tubes

The vapour sampling unit was constructed at CDE to a simple unmetereed flow design, there being no need for an accurately measured vapour sample to be obtained. It was sufficient that the battery powered pump was able to draw 0.5 - 1.0 litre of air each minute through a vapour sampling tube containing Tenax as the vapour adsorbent. The pump batteries (2 x PP3's connected in parallel) last approximately 1 hour before replacement. A low current LED with a 1.2k resistor in parallel with the pump supply voltage indicates that the pump is switched on.

RESTRICTED DATA - EYES ONLY  
**DECLASSIFIED**

RESTRICTED CANUKUS EYES ONLY  
**DECLASSIFIED**

Tenax (a polymer of 2,6-diphenyl-p-phenylene oxide) was used as the adsorbent (3) in the vapour sampling tubes owing to its excellent sample retention properties for a wide range of CW agents and the low background obtained on the subsequent sample analysis by gas chromatography mass spectrometry using the Perkin-Elmer Automatic Thermal Desorption system, (ATD50).

#### Plastic Sample Containers

Sample bags were made at CDE from lay-flat polythene tubing. This was considered a suitable readily available material for the packaging of samples that would be analysed within hours of collection. Polypropylene screw capped bottles were also considered to be entirely adequately for the envisaged use. Slight loss of chemical agent into the packaging material would not compromise the identification analyses.

Such materials may be inferior to Mylar lined aluminium foil bags recommended for use in some sampling kits, if samples were to be in contact for long periods.

#### Swabbing Kit

The kit contained dry cotton wool for collecting samples from surfaces obviously contaminated with liquid agent. The swabs could be moistened with the isopropanol solvent in the kit for collecting samples from a dry surface which was suspected of having been contaminated by agent. Tweezers were supplied to manipulate the swabs if required.

#### Knife with Replaceable Blades

Early kits contained a scalpel with spare blades, as blade replacement by NBC gloved personnel was considered to be very difficult the knife was replaced by a more substantial type, that of the DIY variety with a bigger handle, and a stronger retractable and easier manipulated replaceable blade.

A chisel with a 1" blade was also incorporated at this time as an ideal implement for scraping paint, thickened agent or residues from surfaces.

#### Syringes and Needles

The syringe can be used to collect liquid contamination samples. A needle attached to the syringe will allow samples to be taken from cracks and crevices.

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UK RESTRICTED CANNIBUS EYES ONLY

13



UK RESTRICTED CANNIBUS EYES ONLY

SIRCA SAMPLING KIT - CASE AND CONTENTS

**TAB J - ANALYSIS OF SAMPLES TAKEN DURING THIRD OPERATION  
AT THE TANK**

CMAT Control #  
1998055-0000008

DE [REDACTED] A.E

24 September 1991

CDD/TG 1090/18/265/91

O/LS  
S/CDD - File

ANALYSIS OF [REDACTED] SAMPLES FROM KUWAIT :  
PRELIMINARY REPORT

Samples arrived at CBDE from Kuwait via Germany on 13 September 1991.

Sample Descriptions

Two samples of XAD-4 resin were received. The resin had been sent to the Gulf as a means of transporting samples of CW agents safely. The samples had a definite yellow/brown colour compared with the original white of the resin.

The two samples were labelled :-

"Sample 1 10.8.91".

"Sample 3 10.8.91".

There was no evidence of the Samples 2 and 4 referred to on some of the outer containers. There was no description of the nature of the samples although they are believed to be from a tank in Kuwait thought to contain nitric acid from the SCUD fuel system.

Analytical Results

Extraction of the resin with water showed :-

Sample 1 16 mg nitrate pH 2.2.

Sample 3 35 mg nitrate pH 2.0.

An extract of blank resin of similar weight contained less than <0.2 mg nitrate and had a pH of 6.5.

Extraction of the resin with dichloromethane and analysis by GC/MS showed the presence of no material of CW interest.

The samples were entirely consistent with the contents of the tank being nitric acid and there is no evidence of any CW dimension.

A detailed report will follow in due course.

[REDACTED]  
[REDACTED]  
CDD

DE [REDACTED] A.E

## ***TAB K -US DEPARTMENT OF DEFENSE LESSONS LEARNED***

The following is a compilation of some key lessons learned by US investigators reviewing incidents at the Kuwaiti Girls' School. These lessons learned are solely US Department of Defense in scope and are not intended to reflect the opinions or positions of other Departments or Governments.

### **Communication**

Many individuals and organizations had contact with the tank; however, they did not always communicate with one another, nor did they always know of the others' contact. This was primarily attributable to the various jurisdictions of each organization and the principle of need-to-know. A prime example is the US Army Corps of Engineers which initially investigated the tank but were left out of subsequent discussions. Although the Corps had pertinent information that may have brought this issue to closure early on, it was left out of the proverbial loop due to jurisdiction and the corresponding need-to-know.

Another lesson learned in the area of communication is that reporting solely to command elements rather than specific individuals involved does not always provide the closure desired. Institutional memory is held by individuals not organizations, which often have significant staff turnover. This was the case when the results of the British analysis of the samples on resin were relayed to Task Force Victory. The principals involved from Task Force Victory, including Lieutenant Colonel Killgore, then-Captain Johnson and the rest of the 54<sup>th</sup> Chemical Troop, had already left the theater of operations and were never notified of the results. Interviews with these individuals continually yielded the same outcome: that, to their knowledge, the tank contained chemical warfare agent. Conflicting reporting between those involved and the DoD/MOD, coupled with the fact that a final report was never generated, warranted an investigation into the matter. Notifying those individuals involved could have brought the matter to conclusion rapidly while providing immediate closure to many of the questions and concerns of those involved.

Finally, the need to disseminate necessary intelligence to units entering theater, not just those already in theater, should be addressed. Disseminating information regarding the CAM registering eight bars on mustard in the presence of IRFNA was apparently limited to units in theater at the time of reporting (February 1991). None of the US forces interviewed could confirm receiving this report on the CAM and IRFNA. All of the US forces involved at the Kuwaiti Girls' School entered theater after this message had been relayed. Had they been briefed about this upon entering theater, they may have questioned the results at the time of the testing.

### **Document All Reporting Relating to a Potential CW/BW Incident**

A key lesson learned from this investigation is that all reporting relating to a potential CW/BW incident should be documented. Regardless of whether or not it substantiates the allegation, all evidence should be recorded in written form with the ultimate goal of a formal report on the incident to be disseminated to those involved and other appropriate parties. This is particularly essential when there are many jurisdictions involved. Furthermore, this documentation needs to

be recorded at the time of the incident with all initial and subsequent documentation passed up through the chain-of-command.

### **Doctrine, Tactics, Techniques, Procedures, Training and Requirements**

The knowledge that IRFNA can cause various chemical weapons detectors to register a false positive should be disseminated to those military elements employing them in the field. This knowledge will likely precipitate a change in training to account for these false positives and methods to reconfirm. In addition, requirements may change in order to properly address this new information. It is prudent to upload the known atomic mass unit of IRFNA into the existing Fox vehicles' MM-1s.

Understanding that IRFNA is likely not alone in its ability to cause false positives on chemical weapons detectors, other "battlefield interferents" should be investigated in order to fully address potential alterations in the scope of Doctrine, Tactics, Techniques, Procedures, Training and Requirements.

### **Coordination of Information Among Participants**

There is a definitive need for those reviewing an incident, in which multiple sovereign parties are involved, to understand that each sovereign participants' operating procedures and policy guidelines are often dissimilar to the others'. Some of the concern of both the Senate Committee and the PACGWI that no information dated 1991 could be located could have been promptly addressed had the parties understood the British code on release of information.



# **Information Paper**

## **Medical Surveillance During Operations Desert Shield/Desert Storm**

This Information Paper replaces The Navy Forward Laboratory During Operations Desert Shield/Desert Storm article previously posted under GulfLINK Medical Information. The information in this paper is essentially the same as in the original article. We have made editorial changes, enhanced the graphics, and added hypertext links to improve readability and document navigation. The original article can be found on GulfLINK Retired Documents.

Information Papers are reports of what we know today about military equipment and/or procedures used in the Gulf War of 1990-1991. This information paper on the Navy Forward Laboratory, Biological Warfare Detection, and Preventive Medicine is not an investigative report; instead, it is intended to provide the reader with a basic understanding of the preventive medicine, biological detection, and infectious disease surveillance techniques employed by the Navy Forward Laboratory and unit preventive medicine personnel, and findings that occurred prior to and during the Gulf War. This is an interim paper, not a final paper. We hope that you will read this and contact us with any information that would help us better understand the role of medical surveillance in the Gulf War. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997197-0000-052

Last Update: November 6, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1995 to investigate all possible causes. The Office of the Special Assistant for Gulf War Illnesses assumed responsibility for these investigations on November 12, 1996.

As part of the effort to inform the public about the Office of the Special Assistant for Gulf War Illnesses' progress, DoD is publishing (on the Internet and elsewhere) accounts related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling the accounts. The following information paper will aid understanding of an important medical organization and its role in the Gulf War.



# Information Paper

## Medical Surveillance During

### Operation Desert Storm

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Last Updated: November 6, 1997

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As part of the effort to inform the public about the Gulf War Illness, the Special Assistant for Gulf War Illnesses (DoD) is publishing (on the Internet and elsewhere) documents related to possible causes of Gulf War Illness, along with other documents. The following document or personal testimony will be used in compiling the second. The following information paper will aid understanding of an important medical investigation and its role in the Gulf War.

## **I. BACKGROUND**

### **A. Before the Gulf Crisis**

When US troops deployed to Saudi Arabia in August 1990, military medicine was prepared for the unique health risks our troops faced in the Persian Gulf. The US military operates a network of six overseas infectious disease research laboratories, which serve as training sites for military medical personnel and scientists.<sup>1</sup> These laboratories are regional centers of excellence for basic and applied research that benefit both the US military and host nations by identifying infectious disease risks and developing improved prevention, control, and treatment measures.

One of the oldest overseas laboratories is located in Cairo, Egypt -- the US Naval Medical Research Unit No. 3 (NAMRU-3). NAMRU-3 has operated continuously since 1946, including the 7-year period (1967 to 1973) when there was a break in diplomatic relations between the USA and Egypt.<sup>2</sup> NAMRU-3 has a long and distinguished record training US and foreign medical personnel, assisting local health ministries and the World Health Organization, and representing the United States abroad.

The research efforts at NAMRU-3 are extensive and include vaccine and drug development and disease surveillance. Research investigations frequently involve field studies in various Middle East countries where numerous temporary laboratories have been established over the last 40 years.<sup>3</sup> Consequently, when Operation Desert Shield began, the Navy already had a sophisticated diagnostic laboratory and an active research and surveillance program in the Middle East -- plus medical personnel with extensive experience in this region. US Navy doctors and scientists knew what infectious diseases threatened our troops, what diagnostic tests were needed in Saudi Arabia, and, most critically, how to effectively operate in this region.

### **B. Navy Forward Laboratory**

Beginning in August 1990, US Navy preventive-medicine personnel and scientists began evaluating disease risks among deployed troops. In September 1990, the Navy Forward Laboratory (NFL) was established at the "Marine Corps Hospital" in Al Jubayl, Saudi Arabia.<sup>4</sup> The "Marine Corps Hospital" was an unoccupied civilian hospital that had all the requirements to accommodate a modern diagnostic laboratory: an unused clinical facility, running water, and climate control. Laboratory equipment and supplies were quickly flown into the theater by commercial airlines from Cairo, Egypt, the US Navy Environmental and Preventive Medicine Unit No. 7 (NEPMU-7) in Naples, Italy, and various medical facilities in the US.

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<sup>1</sup> Gambel, J.M. and R.G. Hibbs, "US Military overseas research laboratories," *Military Medicine* 1996, vol. 161: p. 638-645.

<sup>2</sup> Hibbs, R.G., "NAMRU-3: forty-six years of infectious disease research," *Military Medicine* 1993, vol. 158: p. 484-488.

<sup>3</sup> Hibbs, R.G., "NAMRU-3: forty-six years of infectious disease research," *Military Medicine* 1993, vol. 158: p. 484-488.

<sup>4</sup> Hyams, K.C., A.L. Bourgeois, J. Escamilla, J. Burans, and J.N. Woody, "The Navy Forward Laboratory during Operations Desert Shield/Desert Storm," *Military Medicine* 1993, vol. 158: p. 729-732.

The NFL eventually had a staff of eight personnel: four Medical Service Corps officers (microbiologists), two Medical Corps officers (infectious diseases specialists), and two Hospital Corpsmen (advanced laboratory technicians). The NFL was attached to the Naval Logistics Support Command and reported directly to the US Naval Forces Command (NAVCENT) Surgeon, whose leadership was critical in establishing and maintaining the laboratory. The NFL developed into a state-of-the-art infectious disease diagnostic laboratory that had the capabilities of a well-equipped laboratory in the US -- including DNA probes and polymerase chain reaction (PCR) analysis.<sup>5</sup> When fully operational, the NFL served as the theater-wide, infectious diseases reference laboratory for coalition forces. The out of theater support for the NFL was provided by the Naval Medical Research Institute (NMRI), the Armed Forces Research Institute of Medical Sciences, the US Army Medical Research Institute of Infectious Diseases/Walter Reed Army Institute of Research, the National Institute of Health, the Naval Research Laboratory, the Chemical Biologic Defense Establishment in Porton Down, United Kingdom, as well as the US Naval Medical Research Unit No. 3 in Cairo, Egypt and the US Navy Environmental and Preventive Medicine Unit No. 7 in Naples, Italy. Figure 1 shows the location of the NFL and the satellite labs established by the NFL in Al Mishab, Al Khanjar, and Kuwait City.

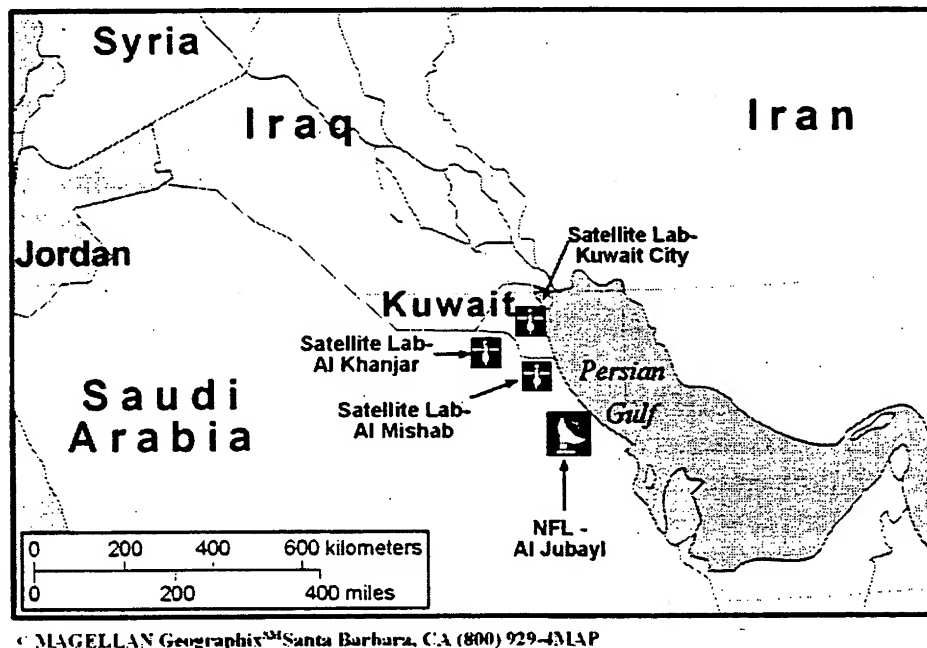


Figure 1 - Location of NFL and Satellite Labs

<sup>5</sup> Hyams, K.C., A.L. Bourgeois, J. Escamilla, J. Burans, and J.N. Woody, "The Navy Forward Laboratory during Operations Desert Shield/Desert Storm," *Military Medicine* 1993, vol. 158: p. 729-732.

## II. NFL's FUNCTIONS AND RESPONSIBILITIES

### A. Naturally Occurring Infections

During Operation Desert Shield, the NFL's main focus was to analyze blood and stool samples and to assist preventive medicine personnel. To carry out these duties, the NFL staff traveled extensively throughout northeastern Saudi Arabia, evaluating patients and assessing health risks. During these travels, staffers were often questioned about the numerous piles of dead animals scattered across the desert. Beginning in August 1990, US veterinary personnel evaluated these animals and determined that their deaths were due to natural causes among the large herds of sheep, goats, and camels kept by the Bedouin in this region.<sup>6</sup> The local residents left the dead animals in specific locations for counting and compensation from the government.<sup>7</sup> In the desert, these dead animals tended to dry out rather than decompose rapidly.

US troops camping near these locations were naturally concerned about the piles of dead animals. There was concern that the animals might be a breeding ground for insect-transmitted diseases.<sup>8</sup> Consequently, military entomologists (experts in insect and pest control) thoroughly sprayed the piles of dead animals with insecticides -- which may in turn explain some subsequent reports of dead animals and insects, particularly among troops who arrived in Saudi Arabia in January and February 1991, at the start of the war. These newly arrived troops would not have known that dead animals had been in the desert for at least five months before hostilities began.

During the early stages of the deployment, the main infectious disease problems were acute diarrhea and the common cold. Epidemiological surveys show that approximately two-thirds of ground troops had acute diarrhea during both Operation Desert Shield and Desert Storm.<sup>9</sup> Nearly all cases of diarrhea were due to the infectious agents NFL personnel had identified during prior US troop deployments to the Middle East -- mainly traveler's diarrhea ("tourista" or the "trots") and *Shigella*. Laboratory analysis identified no cases of typhoid fever, cholera, or amoebic dysentery.<sup>10</sup>

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<sup>6</sup> Spencer, L., "Colonel Alm recounts vital role of veterinarians in Persian Gulf conflict," *Journal of American Veterans Medical Association* 1991, vol. 199: p. 305-309.

<sup>7</sup> Persian Gulf Veterans Coordinating Board, "Unexplained illnesses among Desert Storm veterans: a search for causes, treatment, and cooperation," *Archive of Internal Medicine* 1995, vol. 155: p. 262-268.

<sup>8</sup> Spencer, L., "Colonel Alm recounts vital role of veterinarians in Persian Gulf conflict," *Journal of American Veterans Medical Association* 1991, vol. 199: p. 305-309.

<sup>9</sup> Hyams, K.C., K. Hanson, F.S. Wignall, J. Escamilla, and E.C. Oldfield, "The impact of infectious diseases on the health of US troops deployed to the Persian Gulf during Operations Desert Shield and Desert Storm," *Clinical Infectious Disease* 1995; vol. 20: p. 1497-1504.

<sup>10</sup> Hyams, K.C., K. Hanson, F.S. Wignall, J. Escamilla, and E.C. Oldfield, "The impact of infectious diseases on the health of US troops deployed to the Persian Gulf during Operations Desert Shield and Desert Storm," *Clinical Infectious Disease* 1995; vol. 20: p. 1497-1504.

US troops also frequently had acute upper respiratory infections and complaints (cough, sore throat, sneezing, runny nose). These problems occur any time troops are crowded together and rapidly deployed overseas. Also, there was a concern that the fine blowing sand in Saudi Arabia might be contributing to the respiratory problems. Epidemiological surveys determined, however, that respiratory symptoms were more common among the minority of troops who worked and slept in air-conditioned buildings than among personnel living in tents or open warehouses.<sup>11</sup> Furthermore, troops living in tightly constructed buildings had more symptoms, because in closed and crowded spaces, they were more likely to pass respiratory infections among each other. NFL's analyses found that common viral and bacterial agents, like influenza, caused these respiratory infections.<sup>12</sup>

Medical personnel were also worried about two infectious diseases that had caused problems for US and British troops during World War II -- sand fly fever and cutaneous leishmaniasis (both transmitted by sand flies). Extensive surveillance and testing of US troops, however, did not identify a single case of sand fly fever; and after the war, researchers found only 12 cases of visceral leishmaniasis and 20 cases of cutaneous leishmaniasis in a population of over 750,000 US, British, and Canadian Gulf War veterans.<sup>13</sup> In addition, sand fly vectors could not be found during and after the war in most locations where our troops deployed.<sup>14,15</sup> The very low number of illnesses caused by sand flies and other insects may have been due to:

- Deployment of most troops to barren desert locations where sand flies and their animal hosts do not live
- Deployment of most US troops during the cooler winter months of December to February when insects are least active
- Use of insecticides and repellents

Among US troops, researchers identified only seven cases of malaria, three cases of Q-fever, and one case of West Nile fever.<sup>16</sup> The infectious diseases diagnosed during this wartime deployment were the same ones diagnosed in peacetime when US troops are sent to the Middle East. Although preventive measures can reduce the risk of diarrhea and

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<sup>11</sup> Richards, A.L., K.C. Hyams, D.M. Watts, P.J. Rozmajzl, J.N. Woody, and B.R. Merrell, "Respiratory disease among military personnel in Saudi Arabia during Operation Desert Shield," *American Journal of Public Health* 1993, vol. 83: p. 1326-1329.

<sup>12</sup> Hyams, K.C., K. Hanson, F.S. Wignall, J. Escamilla, and E.C. Oldfield, "The impact of infectious diseases on the health of US troops deployed to the Persian Gulf during Operations Desert Shield and Desert Storm," *Clinical Infectious Disease* 1995; vol. 20: p. 1497-1504.

<sup>13</sup> Magill, A.J., M. Grogil, R.A. Gasser, W. Sun, and C.N. Oster, "Visceral infection caused by *Leishmania tropica* in veterans of Operation Desert Storm," *New England Journal of Medicine* 1993, vol. 328: p. 1383-1387.

<sup>14</sup> Hyams, K.C., K. Hanson, F.S. Wignall, J. Escamilla, and E.C. Oldfield, "The impact of infectious diseases on the health of US troops deployed to the Persian Gulf during Operations Desert Shield and Desert Storm," *Clinical Infectious Disease* 1995; vol. 20: p. 1497-1504.

<sup>15</sup> Cope, S.E., G.W. Schultz, A.L. Richards, et al, "Assessment of arthropod vectors of infectious diseases in areas of US troop deployment in the Persian Gulf," *American Journal of Tropical Medicine and Hygiene* 1996, vol. 54: p. 49-53.

<sup>16</sup> Hyams, K.C., K. Hanson, F.S. Wignall, J. Escamilla, and E.C. Oldfield, "The impact of infectious diseases on the health of US troops deployed to the Persian Gulf during Operations Desert Shield and Desert Storm," *Clinical Infectious Disease* 1995; vol. 20: p. 1497-1504.

respiratory infections, these common ailments cannot be totally avoided during crowded deployments to tropical and developing countries. Only the development of effective vaccines and preventive measures will further reduce the incidence of diarrhea and respiratory infections under such conditions.

## **B. Biological Warfare Detection**

During Operation Desert Storm, the NFL shifted its focus from routine infectious disease problems to the threat of biological warfare (BW).<sup>17</sup> From the beginning of the deployment, it was clear that an in-theater laboratory capable of detecting BW agents was essential to protect US and coalition troops. Therefore, the NFL's diagnostic capabilities and staff were augmented during Operation Desert Shield to deal with the threat. By the start of Operation Desert Storm, the NFL was prepared to detect potential BW agents. Techniques used to identify potential BW agents included:

- Bacteriological identification and microscopy
- Immunologic-based assays for detecting bacterial viral antigens and antibodies
- Molecular techniques, like polymerase chain reaction

Using these techniques, the NFL could analyze both biological samples (like blood) and environmental samples from soil, water, and air collectors.

Based on the best intelligence at the time, the most likely Iraqi BW threats were shells loaded with either anthrax (*Bacillus anthracis*), or botulism (a toxin produced by the bacterium, *Clostridium botulinum*). The bacteria that cause anthrax and botulism both occur naturally in the environment. Anthrax affects livestock and causes disease among humans working closely with infected animals or their hides. Anthrax is a potentially effective BW agent because when inhaled, it causes rapid death from massive bleeding in the lungs.

Botulism is a highly lethal substance which causes disease in the United States when contaminated food is improperly canned or stored. Because minute amounts of this toxin cause very rapid paralysis and death, it is ideal for biological weapons production. The NFL's extensive number of assays could detect both these likely agents and other less likely bacterial, viral, and toxic agents that might potentially be used. After receiving and analyzing samples in-theater, the NFL also sent these samples to laboratories in the United States (US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Maryland) and the United Kingdom (Chemical Biologic Defense Establishment, Porton Down) for further confirmatory analysis. Aflatoxin was considered a less likely BW threat than anthrax or botulinum toxin -- assays in this agent existed in the US, but not at the NFL.

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<sup>17</sup> Hyams, K.C., A.L. Bourgeois, J. Escamilla, J. Burans, and J.N. Woody, "The Navy Forward Laboratory during Operations Desert Shield/Desert Storm," *Military Medicine* 1993, vol. 158: p. 729-732.

During the course of the war, the Navy Forward Laboratory BW team also analyzed some of the dead animals discussed earlier. Using the NFL's array of detection techniques, the BW team analyzed samples from seven dead goats and found no BW agents. Also, analysis of 33 samples from air collectors stationed around the theater of operation showed no evidence of BW contamination. Further, water samples obtained after the war from the Royal Palace in Kuwait City were analyzed and no biological agents were found.

Because of the inherent limitations of any laboratory test, especially newly developed ones, the NFL subjected all samples analyzed for BW agents to repeated testing with dissimilar assay methods to confirm results. Even in the routine hospital and outpatient clinic setting, multiple tests are often required to diagnose a patient's condition because of the limitations of any test method. Because no test for biological or chemical agents is foolproof, multiple tests are even more necessary -- the stakes are too high when chemical or biological agents are in question.

Although it required additional time and labor, the NFL's commitment to overlapping and different assay methods significantly enhanced the lab's BW detection capability during the war. Infectious or chemical agents are sometimes sampled in such a form or amount that they cannot be detected by one method alone. By using multiple methods, the NFL ensured that these agents would not slip detection. This attitude also protected against false negatives and false positives, which are unavoidable problems with all assays. By using different tests to analyze samples, questionable test results could be identified and corrected.

During Operations Desert Shield and Desert Storm, the NFL detected no biological agents in clinical, environmental, and veterinary samples. Nevertheless, these results did not diminish the perceived need for an effective in-theater biological laboratory like the NFL. When large numbers of troops are deployed, they need an early-warning facility to detect hostile biological agents so that preventive and therapeutic measures may be taken.

The Gulf War demonstrated the need for more rapid BW assay methods. This has since been the focus of the military's biological defense research program (BDRP). The present number of detectable BW agents has expanded. New methods have also been designed to detect BW agents in a broader range of samples -- including soil and sand samples, water samples, and even samples obtained by swabbing hard surfaces. A greatly improved rapid assay for biological agents has been developed at the NMRI in Bethesda, Maryland. Assays similar to standard pregnancy tests are now capable of detecting a growing list of BW agents in about 15 minutes.

A large PM section was deployed in the medical battalion of the FSSG. The section consisted of EHOs, entomologists and a team of PMTs. The section was also augmented with additional personnel from the Navy Disease Vector Ecology and Control Center, Jacksonville, Florida. This section brought extensive PM equipment and supplies, including insect and rodent control products, water testing gear, and chlorine to purify water. Its mission was to provide high level back-up for the first line PM personnel at Division and Wing. It was positioned with Combat Service Support Detachments in support of forward Wing and Division units. In addition, the medical battalion PM section provided direct support to battalions in the FSSG. Together, the Marine Corps PM teams ensured the very best in field preventive measures where, and when, they were needed most.

## **B. Surveillance**

One of the most important priorities in any PM effort is to recognize disease and non-battle injury (DNBI) problems early, while they can be more readily controlled. At the beginning of the Gulf deployment, PM personnel (for the first time in US Marine Corps history) established a system of DNBI surveillance to track key illness and injury rates at virtually every Marine and SeaBee Medical Aid Station. At the beginning of the operation, the Navy assigned a Navy Preventive Medicine physician to the Marine Central Command Surgeon's staff to continuously analyze DNBI rates and identify any unusual patterns. In addition, PM personnel continuously monitored all admissions to medical battalion facilities or Navy Fleet Hospitals throughout the Gulf deployment to detect unusual or unanticipated diseases.

By tracking actual DNBI rates and trends in nearly all units, PM personnel were in position to respond immediately to problems and apply appropriate countermeasures. Based on the expected medical threats in the Persian Gulf, special attention was focused on the following DNBI categories, which were established specifically to identify health problems that could degrade combat effectiveness:

**Heat injury:** one of the most significant health threats early in the deployment.

**Diarrhea:** a potentially epidemic problem in field conditions.

**Skin conditions:** a significant cause of lost man-days in many previous conflicts.

**Respiratory conditions:** colds, pneumonia and other respiratory problems are common and can be widespread during any deployment.

**Injury/musculoskeletal conditions:** a major cause of lost man-days from training and deployment activities.

**Eye problems:** eye infections, like "pink eye," can be epidemic in field conditions, also corneal abrasion from blowing sand was a risk in the desert.



**Unexplained fevers:** an unexplained fever may be the first sign of diseases, such as sand fly fever, malaria, and other serious infections.

**Psychiatric conditions:** the stresses of deployment and combat often cause psychiatric symptoms.

**Other conditions:** other problems seen at sick call not fitting into the above categories.

Each week, unit aid stations reviewed their sick call logbooks and determined how many Marines or sailors were treated for the above categories of health problems. A unit-specific DNBI rate was then calculated for each category, based on how many Marines or sailors were assigned to the unit. These simple calculations allowed PM personnel to determine what percentage of the unit was treated during the prior week for these key problems. If the percentage was higher than expected, the cause was investigated. Figure 2 shows the total weekly rates of outpatient visits among approximately 40,000 Marine Corps ground troops stationed in northeastern Saudi Arabia during Desert Shield and Desert Storm.

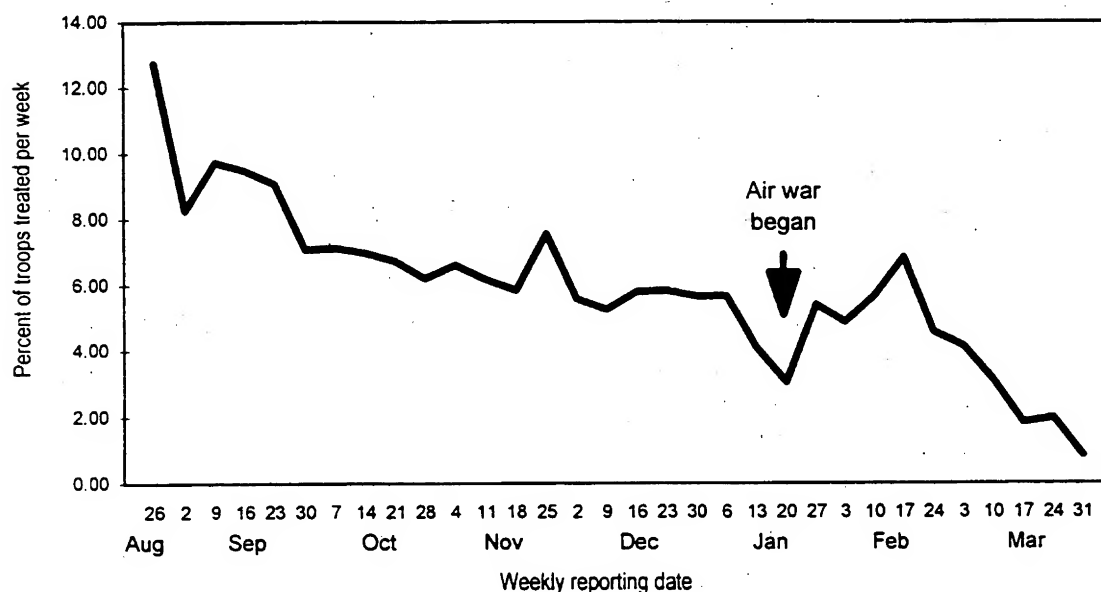


Figure 2 - Marine Outpatient Rates

The DNBI surveillance system demonstrated that PM efforts were very successful in keeping Marines and sailors healthy during Operations Desert Shield and Desert Storm. On average, approximately six percent of the ground troops were treated per week for some type of illness or injury. This compares favorably to the DNBI rates in garrison troops at Camp Pendleton, California, where approximately four percent of personnel per week are treated. Furthermore, DNBI rates decreased during the deployment as troops

adapted to field conditions and PM efforts identified and controlled health threats.

DNBI surveillance proved its worth early in the deployment, when elevated diarrhea rates were detected simultaneously in numerous US Marine units located throughout Saudi Arabia. The force-wide average diarrhea rate rose to approximately four percent per week, with some units experiencing significantly higher rates. Recognizing these elevated diarrhea rates early enabled PM personnel to rapidly identify specific problems with the contract food used in the initial stages of the deployment. The NFL found that the fresh produce initially procured outside of the normal supply system contained local, diarrhea causing bacteria.<sup>20</sup> This problem was rapidly corrected, and diarrhea rates quickly dropped below one percent per week for the remainder of the deployment. This rate of illness is only slightly higher than the normal diarrhea rate seen in garrison at Camp Pendleton.

Figure 3 shows the weekly rates of gastroenteritis among approximately 40,000 Marine Corps ground troops in northeastern Saudi Arabia during Desert Shield and Desert Storm.

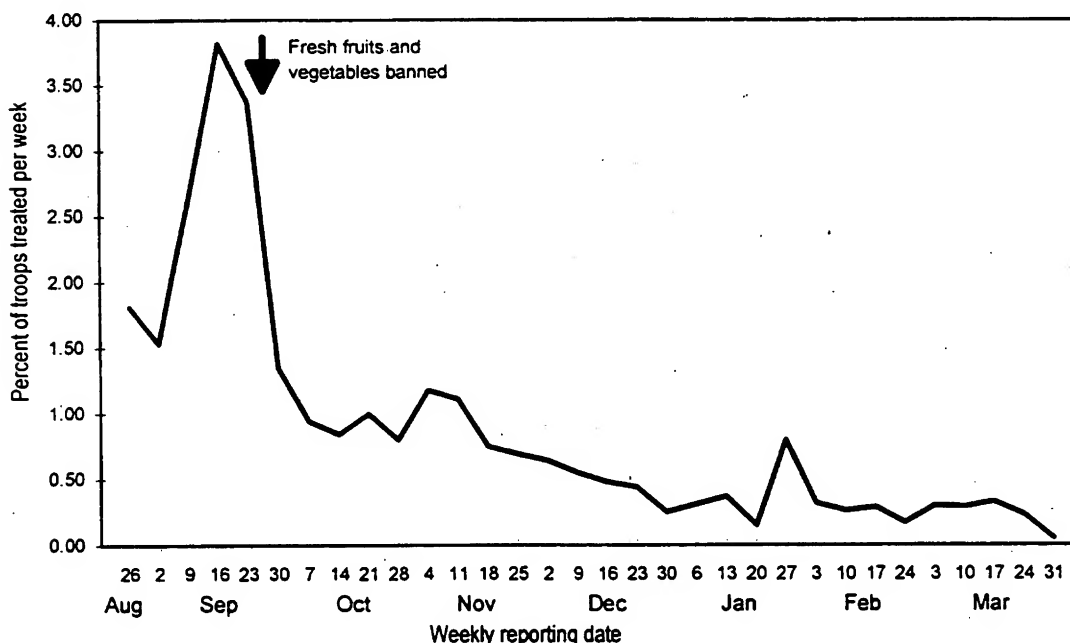


Figure 3 - Marine Gastroenteritis Rates

Respiratory disease rates remained generally low during Operations Desert Shield and Desert Storm, with few cases requiring hospitalization. Rates of outpatient treatment were higher early in the deployment when troops tended to be crowded together during air travel and in staging areas. Respiratory disease rates rapidly declined as troops spread

<sup>20</sup> Hyams, K.C., K. Hanson, F.S. Wignall, J. Escamilla, and E.C. Oldfield, "The impact of infectious diseases on the health of US troops deployed to the Persian Gulf during Operations Desert Shield and Desert Storm," *Clinical Infectious Disease* 1995; vol. 20: p. 1497-1504.

out, but rose again when the weather turned cold. These acute respiratory illness patterns are similar to what is typically seen in the US, and were not a significant problem for US Marines. The British also experienced increased rates of respiratory disease during periods of deployment and crowding.<sup>21</sup> Figure 4 shows the weekly rates of respiratory disease among outpatients in approximately 40,000 Marine Corps ground troops in Saudi Arabia during Desert Shield and Desert Storm. The arrows indicate the two primary periods when Marine Expeditionary Force personnel were being deployed.

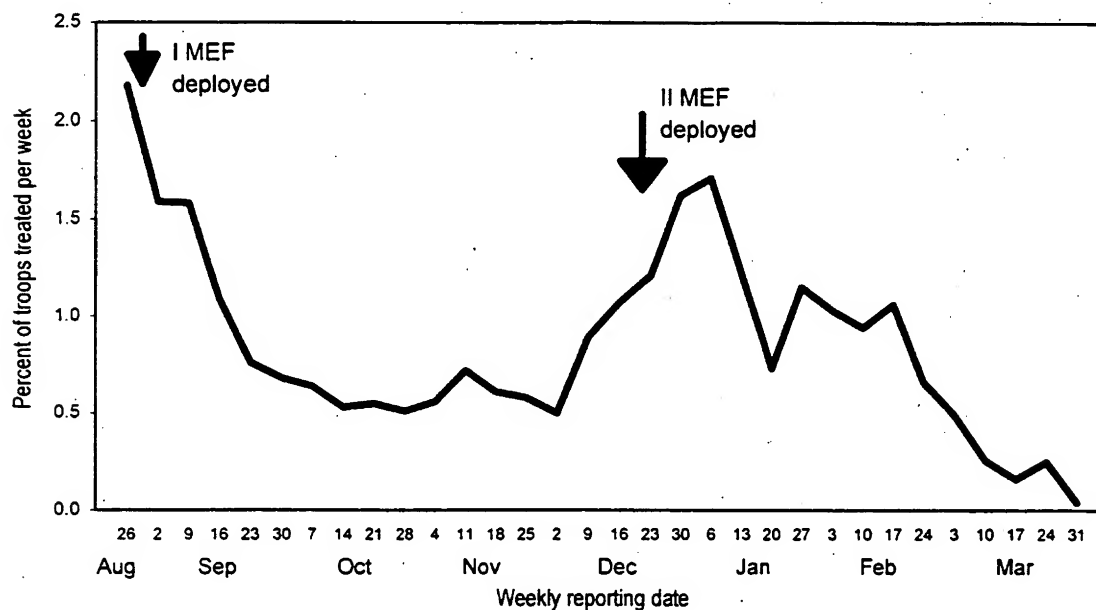


Figure 4 - Marine Respiratory Disease Rates

In all other DNBI categories, illness rates were remarkably low. In spite of extremely hot and humid conditions at the beginning of the deployment, less than 0.3% of the force per week (3 cases per 1000 per week) required treatment at an aid station for heat injury. Strong command emphasis on providing abundant water and acclimatizing troops scored a major victory against this major health threat. In line with these low rates, only about one percent of the force was treated per week for skin problems -- mainly fungal infections and heat rash. This rate is comparable to that seen in a garrison settings during hot and humid conditions.

Significantly, the surveillance system did not detect either sand fly fever or cutaneous leishmaniasis (which causes skin sores) among US Marines. These infectious diseases are transmitted by sand flies and were expected to be major problems in the Persian Gulf. Entomologists, PMTs, and EHOs were on constant lookout for sand fly vectors -- very

<sup>21</sup> Hyams, K.C., K. Hanson, F.S. Wignall, J. Escamilla, and E.C. Oldfield, "The impact of infectious diseases on the health of US troops deployed to the Persian Gulf during Operations Desert Shield and Desert Storm." *Clinical Infectious Disease* 1995; vol. 20: p. 1497-1504.

few were identified.

All other DNBI rates, including injuries, eye problems, psychiatric conditions, and unexplained fevers were remarkably low throughout the deployment, and well within the expected norms. It is noteworthy that the rate of unexplained fevers remained essentially

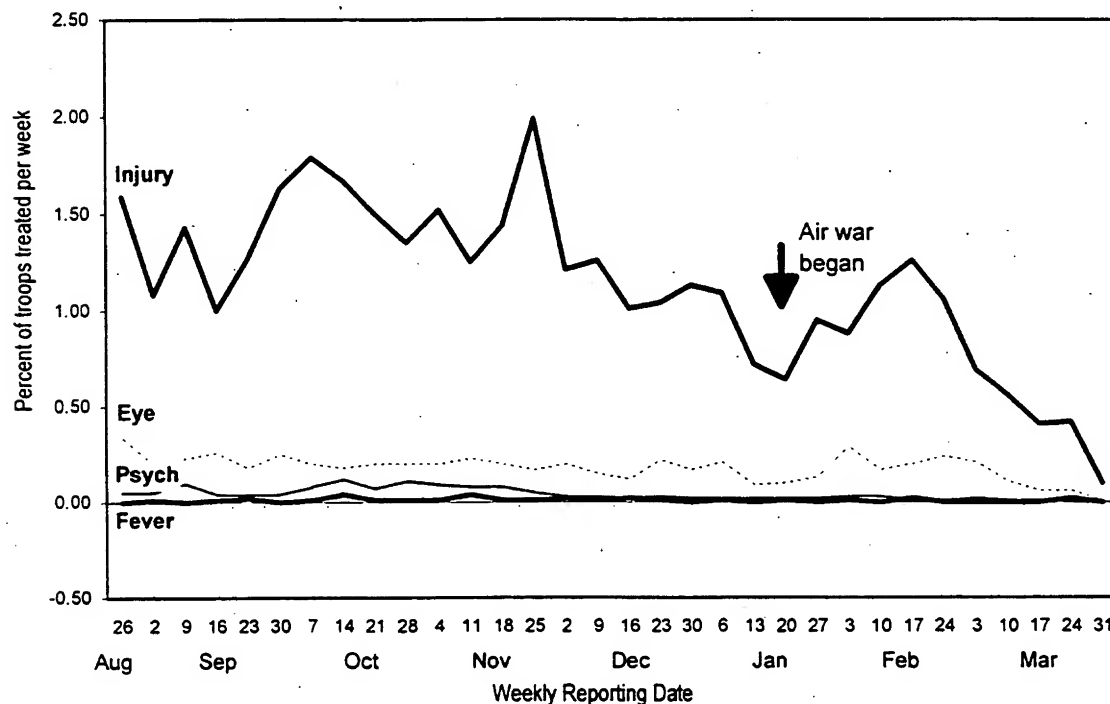


Figure 5 - Marine Rates for Injuries, Eye Problems, Psychiatric Evaluations, and Fevers

zero throughout the deployment. This DNBI category was designed as an early warning indicator to detect unusual insect-borne infections, such as sand fly fever, malaria, and dengue. Most of these infections take time to diagnose, but they typically begin with an acute fever. The absence of unexplained fevers was reassuring to medical and PM personnel, indicating that Marines and sailors were not experiencing serious infections. This finding was corroborated by the near absence of disease carrying sand flies and mosquitoes during the deployment. Furthermore, no individual was hospitalized for these illnesses during the deployment, except for one case of West Nile fever (an acute flu-like viral infection).<sup>22</sup> Figure 5 shows the weekly rates of outpatient visits for injuries, eye problems, psychiatric evaluations, and fevers among Marine Corps ground troops during Desert Shield and Desert Storm.

<sup>22</sup> Hyams, K.C., K. Hanson, F.S. Wignall, J. Escamilla, and E.C. Oldfield, "The impact of infectious diseases on the health of US troops deployed to the Persian Gulf during Operations Desert Shield and Desert Storm," *Clinical Infectious Disease* 1995; vol. 20: p. 1497-1504.

## **IV. ASSESSMENT OF NFL AND PM EFFECTIVENESS**

### **A. NFL Effectiveness**

The NFL provided a critical diagnostic capability during Operations Desert Shield and Desert Storm that enhanced DoD's effective patient care and preventive medicine efforts. Moreover, the NFL provided commanders with accurate information about the nature of the biological threat during this wartime deployment.

The NFL succeeded for two reasons. First, the military's network of overseas infectious diseases research laboratories offered specialized training for DoD personnel in foreign environments and provided support during deployments. Second, all command echelons (particularly the NAVCENT Surgeon and the Assistant Chief, Operational Medicine and Fleet Support at the Bureau of Medicine & Surgery, Department of the Navy) recognized the need for the NFL from the beginning of Desert Shield.

Since the end of the Gulf War, the forward laboratory concept has been institutionalized into the Forward Deployed Laboratory under the coordination of the Navy Environmental Health Center in Norfolk, Virginia. When deployed, this laboratory has a "core" infectious disease diagnostic unit. Layered on top of this "core" are specialized teams, like BW detection. Presently, the BW detection team is provided by the Biological Defense Research Program at the Naval Medical Research Institute (NMRI), where a mobile laboratory for BW detection has been developed.

The NMRI mobile BW laboratory also has critical national security uses outside of military deployments. NMRI laboratory personnel and the mobile laboratory have been used to actively support US and international agencies in identifying potential BW threats -- including the United Nations controlled sanctions of Iraq and the recent B'nai B'rith incident in Washington, DC in 1997, involving a suspicious package.

### **B. Preventive Medicine Effectiveness**

The Gulf War was unique in that there was an ongoing effort to monitor DNBI rates in a surveillance system backed up by a sophisticated on-site laboratory capability. Also, the US military understood and was ready for the health threats our troops encountered in the Gulf War. Consequently, the DNBI rate during this war was lower than in previous major conflicts involving US military personnel.<sup>23,24</sup> The good health of US troops was due in part to comprehensive preventive medicine efforts by all Services, accurate and rapid laboratory diagnosis, and the extensive health care system that was established in

<sup>23</sup> Lindsay, G.C. and C. Dasey. "Operations Desert Shield/Storm infectious disease rates: A fortuitous anomaly," United States Army Medical Research and Development Command News, February 1992, p. 5-6.

<sup>24</sup> Defense Science Board, Report of the Defense Science Board Task Force on Persian Gulf War Health Effects, Washington, DC: Office of the Under Secretary of Defense for Acquisition and Technology, June 1994.

Saudi Arabia during Operation Desert Shield.<sup>25</sup>

Besides these medical measures, several fortunate circumstances aided US troops:

- Troops deployed to barren desert locations during cooler winter months when insect activity is lowest
- Troop contact with non-military populations was limited
- Troop access to alcohol was very limited
- In the last several decades, Saudi Arabia and Kuwait made great strides in public health and the elimination of local diseases

Although the pioneering system of DNBI surveillance was not perfect, it was a critical tool in immediately defining the major patterns of illness and injury in each Marine unit for most of the deployment. Combined with hospital surveillance, it clearly demonstrated that US Marine Corps and Navy ground personnel remained very healthy during Operations Desert Shield and Desert Storm. Also, when a problem arose it was quickly resolved.

This DNBI surveillance system proved so successful that it was adopted as the standard approach for all subsequent joint deployments involving US military personnel. It has been modified and successfully used during Operation Restore Hope in Somalia, during the Haiti intervention, and during operations in Bosnia.

Although wars cannot be conducted as large epidemiological studies, more medical surveillance information was collected on US troops during the Gulf War than in prior wars. Since the end of the Gulf War, this data has aided investigators in the search for the causes of veterans' health problems. To date, the primary chronic infectious disease problem identified among veterans has been 12 cases of visceral leishmania infection. Nevertheless, investigations are continuing on other possible chronic infectious disease problems.

Following the war, the principal unanswered health question has been the unknown nature and causes of the unexplained symptoms experienced by some Gulf War veterans. Because similar physical symptoms have been reported by war veterans since the US Civil War,<sup>26</sup> veterans of future wars could also experience comparable health problems. The improved surveillance and diagnostic methods pioneered during the Gulf War and the more recent improvements in medical record keeping will help the DoD and Veterans Affairs provide the best health care possible for both current and future veterans.

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<sup>25</sup> Blanck, R.R. and W.H. Bell, Special reports: "Medical aspects of the Persian Gulf war," "Medical support for American troops in the Persian Gulf," *New England Journal of Medicine* 1991, vol. 324: p. 857-859.

<sup>26</sup> Hyams, K.C., F.S. Wignall, and R. Roswell, "War syndromes and their evaluation: From the US Civil War to the Persian Gulf War," *Annals of Internal Medicine* 1996, vol. 125: p. 398-405.

## ***TAB A - Acronym Listing***

### **Acronyms**

BDRP .....	Biological Defense Research Program
BW .....	biological warfare
DNA .....	deoxyribonucleic acid
DNBI .....	disease and non-battle injury
DoD .....	Department of Defense
EHO .....	Environmental Health Officer
FSSG .....	Force Service Support Group
NAMRU-3 .....	US Naval Medical Research Unit No.3
NAVCENT .....	Navy Central Command
NEPMU-7 .....	US Navy Environmental and Preventive Medicine Unit No.7
NFL .....	Naval Forward Laboratory
NMRI .....	US Navy Medical Research Institute
OSAGWI .....	Office of the Special Assistant for Gulf War Illnesses
PCR .....	polymerase chain reaction
PM .....	Preventive Medicine
PMT .....	Preventive Medicine Technician
SeaBees .....	Naval Mobile Construction Battalions

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# Case Narrative

## US Marine Corps Minefield Breaching

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on US Marine Corps Minefield Breaching. Incidents discussed in this narrative were reported by Task Force Ripper in the 1st Marine Division and by the 1st Battalion, 6th Marines in the 2d Marine Division. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding US Marine Corps Minefield Breaching. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997191-0003-330

Last Update: July 29, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DOD) established a task force in June 1995 to investigate all possible causes. On 12 November 1996, responsibility for these investigations was assumed by the Investigation and Analysis Directorate (IAD), Office of the Special Assistant for Gulf War Illnesses (OSAGWI) which has continued to investigate the events related to the US Marine Corps Minefield Breaching operations. Its interim report is contained here.

As part of the effort to inform the public about the progress of this effort, DOD is publishing on the Internet and elsewhere accounts related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling the account. The narrative that follows is such an account.

## METHODOLOGY

During and after the Gulf War, people reported that they had been exposed to chemical warfare agents. To investigate these incidents and to determine if chemical weapons were used, the DOD developed a methodology for investigation and validation based on work done by the United Nations and the international community (see Tab D) where the criteria include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation or human/animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by experts.

Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

By following this methodology and accumulating anecdotal, documentary, and physical evidence, and by interviewing eyewitnesses and key personnel, and analyzing the results, the investigator can assess the validity of the presence of chemical warfare agents on the battlefield. Because information from various sources may be contradictory, we have developed an assessment scale (Figure 1) ranging from "Definitely" to "Definitely Not" with intermediate assessments of "Likely," "Unlikely," and "Indeterminate." This assessment is tentative, based on facts available as of the date of the report publication; each case is reassessed over time based on new information and feedback.

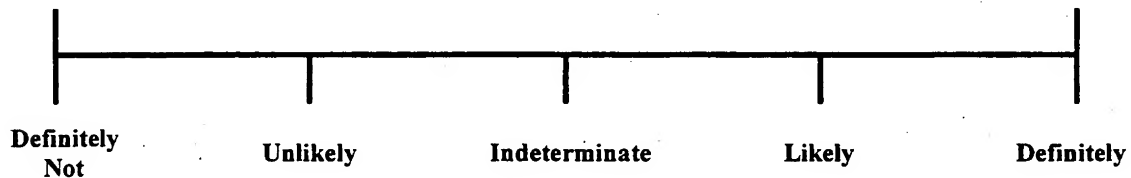


Figure 1. Assessment of Chemical Warfare Agent Presence

The standard for making the assessment is based on common sense: do the available facts lead a reasonable person to conclude that chemical warfare agents were or were not present? When insufficient information is available, the assessment is "Indeterminate" until more evidence can be found.

## SUMMARY

During the Persian Gulf War, U.S. Marine Corps forces reported several incidents of possible exposure to chemical warfare agents. After the war, in testimony to the Presidential Advisory Committee on Gulf War Veterans' Illnesses, Marine Gunnery Sergeant (GySgt) George Grass reported three more incidents. Based on the reports of these incidents, we established four cases:

- an incident at an Iraqi ammunition supply point (ASP) southwest of Kuwait City that we call the ASP/Orchard case;
- the incidents at Al Jaber air field during the first and second days of the ground war;
- several reports of positive detections by the 11th Marine regiment and its subordinate battalions during the course of the air war and the ground war; and
- minefield breaching operations of the 1st and 2d Marine Divisions during the first day of the ground war.

The narrative that follows reports the Minefield Breaching case; narratives describing the other cases will be released separately.

The Marines had to breach the two minefields that stretched across southern Kuwait. From these breaching operations came two accounts that describe chemical detections and possible exposures at different locations on the battlefield. Both events occurred in the morning of February 24, 1991:

- The first incident occurred in Task Force Ripper of the 1st Battalion, 7th Marine Regiment, 1st Marine Division and was reported in testimony by GySgt George Grass, a Marine Corps Fox reconnaissance vehicle Commander, who had been assigned to Task Force Ripper.
- The second incident occurred in the 1st Battalion, 6th Marine Regiment (Reinforced), 2d Marine Division, and was mentioned in a Marine Corps monograph.

The first reported chemical agent incident occurred in the 1st Marine Division when the Fox reconnaissance vehicle detected what GySgt Grass identified as a "trace." He relayed his finding to the Task Force Ripper NBC officer, but not to units in the 1st Marine Division because there was insufficient evidence to confirm the presence of a chemical warfare agent. Even if it had been present, the NBC officer judged that a trace would not have been harmful to troops moving rapidly through the breaches. There was no evidence collected, and no troops reported any chemical effects despite traveling through the minefield breaches with faces and hands exposed. The assessment for this incident is that the presence of a chemical warfare agent is "Unlikely."

In the 2d Marine Division incident, the response was different; personnel were alerted to the possible presence of chemical warfare agents. Those in the area of the possible

contamination took protective measures and continued their assault through the breach. The Fox reconnaissance vehicle that sounded the alarm to the possibility of chemical agents analyzed an air sample with its mass spectrometer, but did not print the results of the spectral analysis. After-action analysis of the Fox tape was limited to entries printed automatically since the spectrum (all detected ions) was not printed. Nevertheless, reviews of the Fox tape by separate agencies concluded that the alarms were "false positives." One Marine reportedly was injured by a chemical warfare agent. Individuals who saw the injury reported conflicting observations and the medical evaluation of the Marine's complaint did not substantiate his report. He was subsequently denied a Purple Heart medal. The assessment of this incident is that the presence of a chemical warfare agent is "Unlikely."

## NARRATIVE<sup>1</sup>

The 1st and 2d Marine Divisions, the ground maneuver elements of the First Marine Expeditionary Force (I MEF), were positioned along the northern boundary of Saudi Arabia with the mission to attack north into Kuwait. The I MEF was tasked to breach (clear openings in) two heavily defended minefield belts,<sup>2</sup> advance past Ahmed Al Jaber air base taking key sites along the way, and converge on Kuwait City to liberate the capital. The areas of operations are shown in Figure 2. The 1st Marine Division eventually opened 14 lanes; the 2d Marine Division opened six.<sup>3</sup>

A full list of the units involved in this case is provided at Tab B. The 1st Marine Division was made up of units from the 1st Marine, 3d Marine, 7th Marine, and 11th Marine regiments (as well as units of other Marine regiments assigned to the 1st Marine Division). For the conduct of the ground war, the 1st Marine Division was further organized into Task Forces (e.g., Ripper, Papa Bear). The 2d Marine Division was comprised of units of the 6th Marines; the 8th Marines; the 10th Marines; the Army's 1st Brigade, 2d Armored Division; and other supporting Marine units.

Final preparations and briefings took place on day G-1 (February 23, 1991) as commanders reiterated to their troops the high potential for use of chemical warfare agents by the Iraqis,<sup>4</sup> the need for speed through the minefield breaches,<sup>5</sup> and, above all,

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<sup>1</sup> An acronym listing is provided at Tab A.

<sup>2</sup> Two minefield belts (sometimes called obstacle belts in unit logs) extended from the Persian Gulf, generally across south-central Kuwait below the Al Bourquan oil fields and north of the Al Wafrah oil fields. "Minefield depth varied from 60 to 150 meters and each belt was enclosed on all four sides with concertina wire or ... barbed wire ... reinforced with engineer stakes." "Breaching Operations in Southwest Asia", Marine Corps Research Center Research Paper #92-0004, pp. 3-4.

<sup>3</sup> Final Report to Congress, "Conduct of the Persian Gulf War," April 1992, p. 265.

<sup>4</sup> For example, the "Iraqis artillery will use maximum chemical rounds until neutralized," 2d Assault Amphibian Battalion Operations Order 2-91, 211800C Feb 1991, p. 1.

<sup>5</sup> For example, "Commanding Officer's intent: I intend to pass as quickly as possible from assembly point to the far side of the breach," 2d Assault Amphibian Battalion Operations Order 2-91, 211800C Feb 1991, p. 3.

to "take care of your men."<sup>6</sup> Lieutenant General Carlton W. Fulford, Jr., who, as a Colonel, commanded Task Force Ripper, testified<sup>7</sup> that

...we took this threat of chemical involvement very seriously. We had intelligence ... that the Iraqi forces had the potential, had the capability. We [had] the very best NBC equipment that the Marine Corps had in its inventory at that time. And throughout many months in Saudi Arabia, we trained very, very hard on the detection, protection, and decontamination of our forces.

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<sup>6</sup> Letter, Commanding Officer, 1st Battalion, 7th Marines, Subject: Operation Desert Storm 1st Battalion, 7th Marines Maneuver Synopsis, March 14, 1991.

<sup>7</sup> Testimony of Lt. Gen. Carlton W. Fulford, Jr., before the Armed Services Committee, U.S. Senate, February 27, 1997.

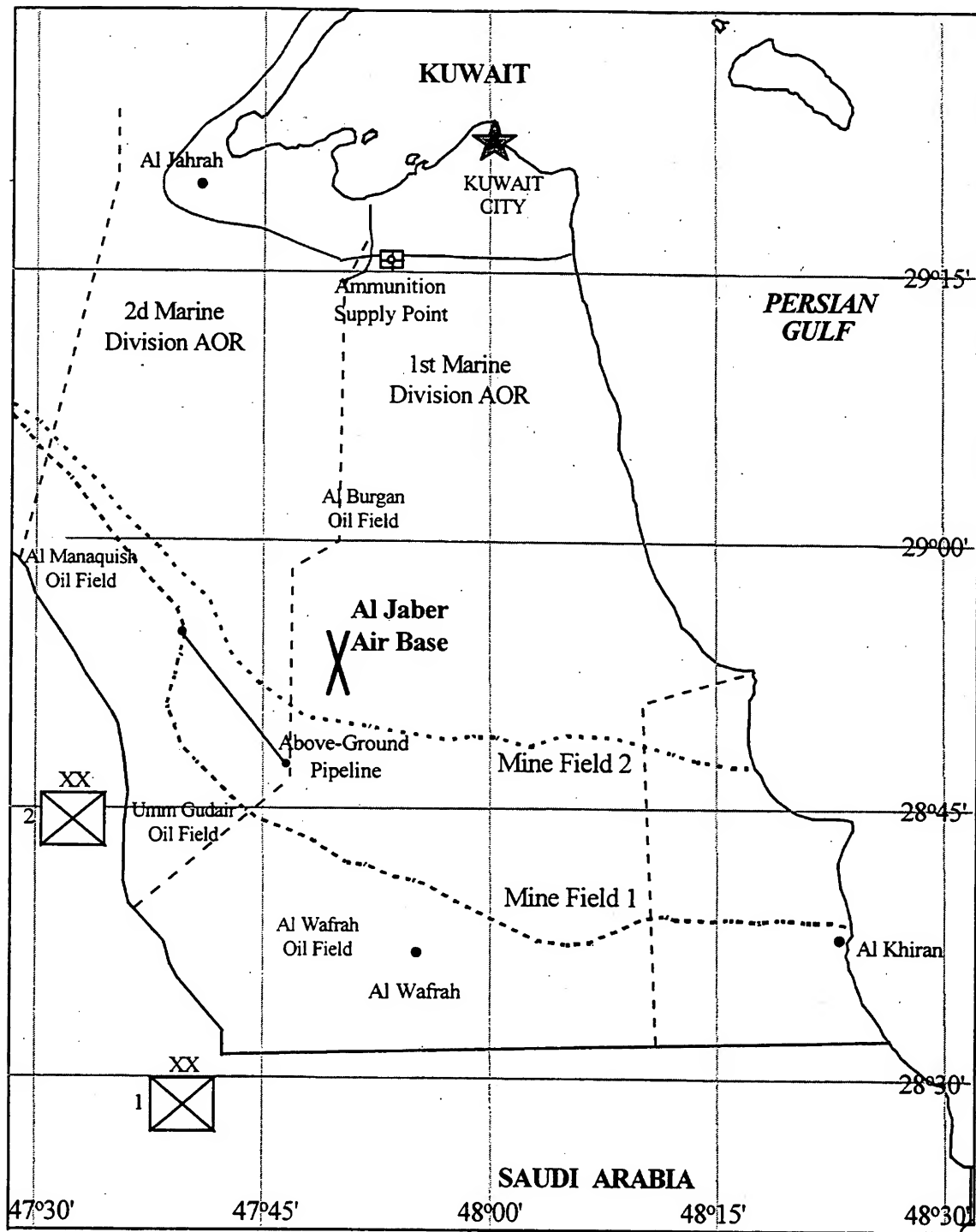


Figure 2. U.S. Marine Corps Areas of Operations

Prior to leaving their assembly areas, personnel assumed Mission-Oriented Protective Posture 2 (MOPP2)<sup>8</sup> in which they were clothed in a chemical protective over-garment, including boots. They carried their protective masks and gloves, which could be donned in seconds should there be any indication of chemical agent attack. The 7th Marines assumed MOPP2 at 1600 hours on February 23rd.<sup>9</sup> These actions were consistent with Marine doctrine which defines the MOPP levels and the threat assessment process. It also advises commanders to balance the threat of exposure and the mission-degrading effects of wearing the protective overgarments against the "factors of mission, environment, and soldier."<sup>10</sup>

Although the I MEF officially began the assault at 0400 hours on February 24, 1991, the 1st Marine Division started moving forward through the first minefield to their defensive positions earlier in the night with infiltration Task Forces Taro and Grizzly. The 1st Marine Division breached the first minefield from positions just west and south of the "elbow" of the southern Kuwait border. The 2d Marine Division entered Kuwait between the Umm Gudair (south) and Al Manaquish oil fields about 25 kilometers northwest of the 1st Marine Division.

The Marines breached the minefields "by the book" to "locate the leading edge, breach the lane, proof<sup>11</sup> the lane, and mark the lane."<sup>12</sup> However, the specific methods and order of maneuver for each Marine division differed slightly. After locating the leading edge of the minefield, combat engineers, using mine-clearing explosive line charges, opened lanes through the minefields. The over-pressure of the line charges detonated the mines in the minefield or blew them out of position. The line charges were followed by armored equipment with plows, rakes, or rollers that cleared and proofed the lanes. A team of combat engineers followed and marked the edges and/or center of the lanes. While doing so, they cleared mines or obstacles that might have fallen back into the cleared lanes and destroyed anything too dangerous to move. Using these procedures, the Marines cleared lanes wide enough for their attacking forces to pass.

During breaching operations, all personnel were told to be alert for evidence of chemical contamination or attack, such as chemical alarms, chemical agent monitor alerts, or individuals exhibiting symptoms of chemical contact. If anyone suspected a chemical

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<sup>8</sup> The authoritative guidance on balancing the appropriate MOPP level to the mission is the U.S. Army/Marine Corps FM 3-4/FMFM 11-9, "NBC Protection," January 1, 1991. The Navy had a different configuration for MOPP2 (ref: *U.S. Navy Ships Technical Manual* Chapter 470 Change 4, September 1991, "Shipboard BW/CW Defense and Countermeasures"), but the Marine and Army personnel followed FM 3-4/FMFM 11-9.

<sup>9</sup> "Command Chronology for the Period 1 January to 28 February 1991," 7th Marine Regiment, April 25, 1991, p. 2-2.

<sup>10</sup> *U. S. Army/Marine Corps Field Manual FM 3-4/FMFM 11-9*, "NBC Protection," January 1, 1991, pp. 2-16.

<sup>11</sup> Proofing the lane requires specially equipped armored vehicles to pass through the opening made by the explosive charges to show proof that no mines remain that would cause damage or injury.

<sup>12</sup> "Breaching Operations in Southwest Asia", Marine Corps Research Center Research Paper #92-0004, July 1991, p. 5.



incident, they were directed to call a Fox<sup>13</sup> reconnaissance vehicle to check out the area. Each Marine division was allocated four Fox reconnaissance vehicles, and usually one was assigned to each maneuver regiment.

The Fox reconnaissance vehicles were designed to monitor and identify persistent liquid chemical ground contamination, however, the Fox was also used for on-the-move vapor detection. It is not optimized for this mission, nor is its alerting capability in this method of operation as good as that of other chemical detectors. To completely detect and verify the presence of a chemical agent requires the Fox to perform a spectral analysis using the Fox's on-board MM-1 mobile mass spectrometer,<sup>14</sup> followed by an analysis of the spectrum printout by a qualified expert trained in the chemical analysis of ion masses.<sup>15</sup> It requires several minutes to obtain a good spectral readout of the agent and collect a sample to assure that initial indications are not affected by contaminants from the battlefield (e.g., smoke, diesel exhaust, oil, etc.)

### **Operations of the 1st Marine Division**

Combat Engineers of the 1st Marine Division, working in cool, drizzly, and heavily overcast conditions due to weather and oil smoke, opened four assault lanes in the first minefield by 0715 hours and four more in the second minefield by 1230 hours.<sup>16</sup> By 1420 hours, all 1st Division lanes in both minefields had been opened. Forces of the 1st Marine Division passed quickly through the breaches (Figure 3), encountering no resistance in the first minefield and overcoming light resistance through the second minefield. They proceeded to Al Jaber air base by evening. According to 7th Marine records,<sup>17</sup> Task Force Ripper (the Division's lead maneuver element) logged no potential or actual exposure to chemical warfare agents throughout all breaching operations.

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<sup>13</sup> During Operations Desert Shield, Germany provided the United States with 60 FUCHS chemical reconnaissance vehicles, which came to be called "Fox" reconnaissance vehicles. Ten of these vehicles went to the Marines, with four assigned to each Division.

<sup>14</sup> U.S. Army FM 3-101-2, "NBC Reconnaissance Squad/Platoon (FOX) Operations - Tactics, Techniques, and Procedures," August 10, 1994, pp. 5-2, 5-3.

<sup>15</sup> Each chemical warfare agent is comprised of a unique combination of ions, called a spectrum, and the Spectrometer has the capability of evaluating the ion pattern of any detected chemical against a library of ion spectrums of chemical warfare agents.

<sup>16</sup> "Command Chronology for the 1st Combat Engineering Battalion, 1 Jan to 28 Feb 91," March 15, 1991.

<sup>17</sup> Neither the Task Force Ripper (1st Battalion, 7th Marines) Command Chronology for the Period 1 January to 28 February 1991, the "7th Marines Log" for February 24, 1991, nor the 7th Marines "Command Chronology for Period 1 January to 28 February 1991" records a reference to the 1st Battalion, 7th Marines or Task Force Ripper encountering a chemical agent during breaching operations.

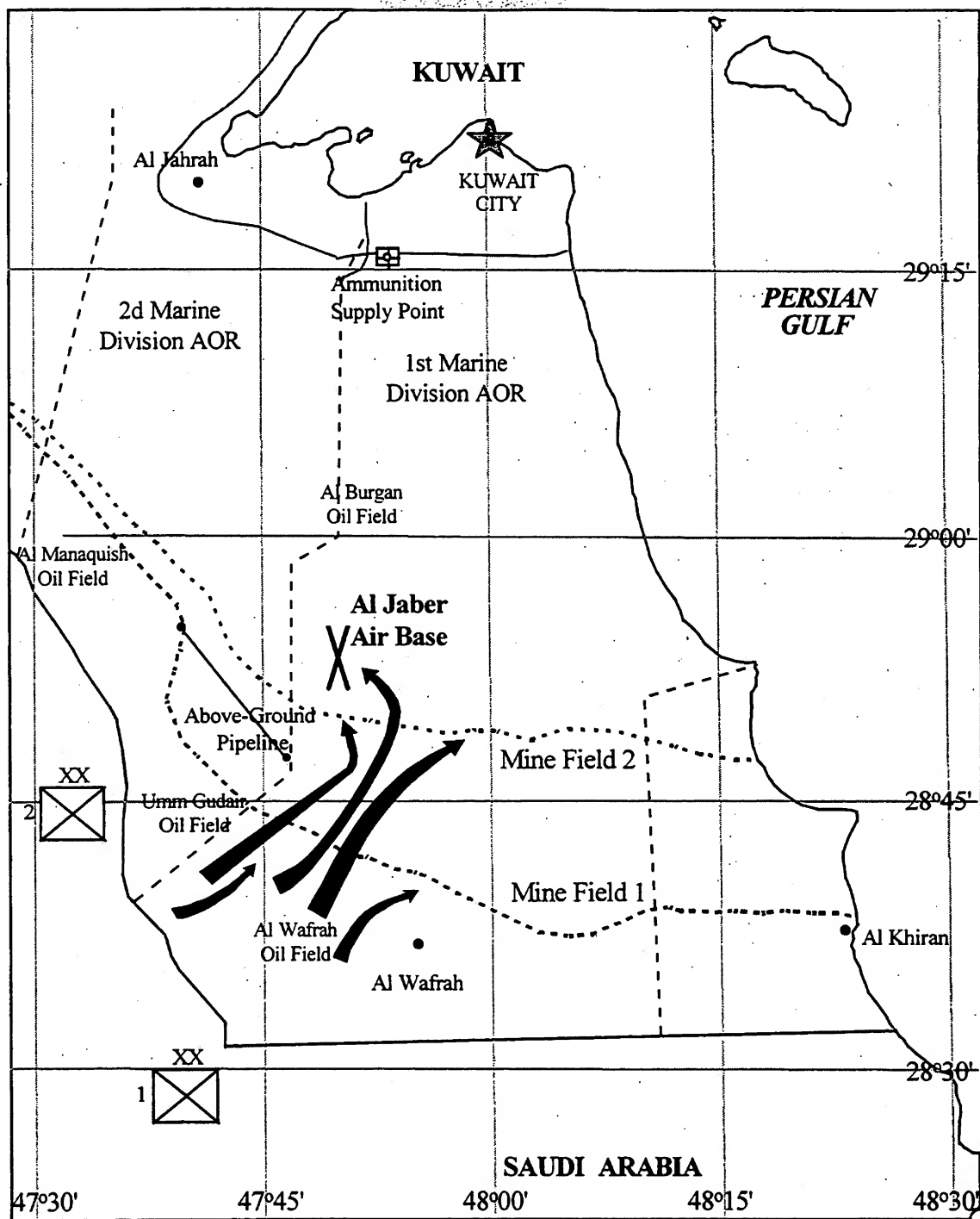


Figure 3. 1st Marine Division Minefield Breaching

### ***Initial Report***

After the war, GySgt George Grass, who was the commander of the Fox reconnaissance vehicle assigned in direct support of Task Force Ripper, testified to the Presidential Advisory Committee and to subcommittees of Congress, that while he was crossing the first minefield breach, his vehicle detected

... small traces of nerve agent in the air. The computer system notified us that the amount of chemical agent vapor in the air was not significant enough to produce any casualties.<sup>18</sup> As a result, it was impossible for the Mass Spectrometer to run a complete check on the agent except by visually observing the agent and spectrum on the screen.<sup>19</sup> These minute readings continued on the screen for the duration of each lane surveyed. Once my Fox vehicle departed the first minefield breach, those readings went away....<sup>20</sup>

He testified that the amounts were trace, but the MM-1 did not alarm so the MM-1 did not recognize the "trace" as a chemical warfare agent. He also indicated that his Fox was operating using the vapor method of detection. In his testimony to the Presidential Advisory Committee,<sup>21</sup> he stated that he reported the trace reading "face-to-face" (i.e., after the breaching) to both the 3rd Tank Battalion's Nuclear, Biological, Chemical (NBC) Officer and the Task Force Ripper NBC Officer. There is no record of any follow-up testing done to confirm this report.

### ***Corroborating Information***

Following our methodology, efforts were made to confirm the events and to find evidence to substantiate the presence of chemical warfare agents. In congressional testimony<sup>22</sup>, CWO Joseph P. Cottrell, the Task Force Ripper NBC officer, confirmed that he had been informed of the Fox's findings, but he remembered the agents to be blister, not nerve. In answering a question, he clarified that he remembered the detection was "mustard-type blister." He also stated that the reported levels were below an immediate threat to humans and below the level that would cause symptoms. Except for the agent type, this

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<sup>18</sup> The Fox provides readings of possible presence based upon the intensity level of the ions present in the sample relative to a background reading taken in a clean environment, but makes no determination of a level to "produce casualties."

<sup>19</sup> A Fox can take and print a spectrum at any time, but is more accurate if the MM-1 is operating at a lower temperature. If the spectrum is visible on the screen, it can be printed by depressing the "Print" button.

<sup>20</sup> Testimony to the Presidential Advisory Committee, GySgt George J. Grass, Task Force Ripper Fox reconnaissance vehicle Commander, May 1, 1996.

<sup>21</sup> Testimony to Presidential Advisory Committee, GySgt George J. Grass, Task Force Ripper Fox reconnaissance vehicle Commander, May 1, 1996.

<sup>22</sup> Testimony of CWO Joseph P. Cottrell, USMC, at the Hearing before the Oversight and Investigations Subcommittee of the Committee on Armed Services, House of Representatives, November 18, 1993.

testimony is consistent with what GySgt Grass said -- namely, that the trace amounts were not significant enough to cause casualties. It was CWO Cottrell's assessment that crossing the breach did not pose a threat or require subsequent decontamination because the suspected agent was at a trace level and the rapidly moving Marines were in the area for only a short period of time. Given these factors, he did not send out an NBC-1<sup>23</sup> report. He was aware of no other detections in the 1st Marine Division breach lanes.

GySgt Grass and CWO Cottrell followed their agreed-upon procedure to evaluate a possible chemical detection before alerting the task force or higher headquarters about a possible chemical incident. They agreed that for this incident, without more proof, they would not inform the Division personnel. Also, the source of the readings was questionable because there was no apparent method for delivery of the suspected chemical agent.

Although this Fox crew was supporting Task Force Ripper, it was under the direct control of the 3d Tank Battalion's NBC officer during the breaching operations. (The Fox crew was released back to Task Force Ripper after completing the breach.) The 3d Tank Battalion NBC officer had a 5702 Military Occupational Specialty (MOS),<sup>24</sup> had many years of NBC experience, and was in a position to be aware of any chemical incidents or casualties during the 1st Marine Division breaching operations. The 3d Tank NBC Officer also had personally written the NBC portion of the Operation Order for the breaching operations. And even though the Marines had new equipment (Chemical Agent Monitors and Fox reconnaissance vehicles), his instructions were clear -- follow the basic NBC procedures to sound the alarm, put on the mask and gloves (MOPP4), report to Regimental Headquarters, and begin supplementary testing with an M256 kit. He stated that there were no NBC reports generated, no reports of casualties or injuries, nothing to suggest that a higher MOPP level was required during the breaching operations or anything suggesting that a chemical incident had occurred.<sup>25</sup> He also stated that during his entire time in the Gulf, he does not recall anyone reporting any positive chemical warfare agent readings to him. He added that GySgt Grass had communications capability to alert the Division of a chemical detection, but he never did.<sup>26</sup>

The 1st Marine Division NBC Officer (also with a 5702 MOS and many years of NBC experience) served on the Operations staff in the Division Headquarters. He also would have been aware of any NBC reports, any reports from other units, or any reports of

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<sup>23</sup> An NBC-1 is the initial report of potential observation. The NBC-2 report is a corroboration from a second or more observers following an initial NBC-1 report. The NBC-3 report issues an immediate warning of expected contamination. NBC-4 reports the results of reconnaissance, monitoring, and surveying of the suspected attack or contamination. NBC-5 identifies the actual areas of contamination, and NBC-6 provides a detailed report on chemical-biological attacks. U.S. Army, FM 3-100, "NBC Operations," p. 2-10.

<sup>24</sup> The 5702 Military Occupational Specialty (MOS) is awarded to Marine Corps personnel trained in NBC operations.

<sup>25</sup> Lead Sheet 735, p. 6, Interview of 3d Tank Battalion NBC Officer, April 26, 1996.

<sup>26</sup> Lead Sheet 767, p. 1, Interview of 3d Tank Battalion NBC Officer, May 21, 1996.

casualties. He specifically stated that no NBC reports were generated during the breaching operations in the 1st Marine Division and that there was nothing to suggest that there were even trace detections. While many of the Marines were only in MOPP2, there are no reports of casualties or any chemical exposure. His assessment of the testimony of GySgt Grass was that there was no incident during the breaching.<sup>27</sup>

The driver of the same Task Force Ripper Fox reconnaissance vehicle was another eyewitness to the events of the breaching operations. In a written statement, he recalled the results of the reconnaissance of the 1st Marine Division breaching lanes differently than GySgt Grass: "All four lanes of both mine belts were checked and nothing was detected."<sup>28</sup> On the other hand, the MM-1 operator of this Fox reconnaissance vehicle supported GySgt Grass' testimony in his own testimony to the Presidential Advisory Committee.<sup>29</sup> He added that the MM-1 was unable to get a spectrum of the indications he saw on his screen.

Efforts to find physical evidence of the suspected chemical warfare agent were unsuccessful because the Fox did not collect a sample nor print a spectrum. The lack of a spectrum is significant. Only by comparing the spectrum of the chemical sample against the Fox's library of chemical warfare agents can the Fox determine whether or not it has properly detected a chemical warfare agent. The inability of the MM-1 to match the ion pattern of a sample to its library of chemical warfare agents suggests that the sample contained none of the known threat agents.

Without the printout of the spectrum, the possible presence of chemical agent cannot be verified. A subject-matter expert (who works for the program manager for the Fox vehicles) at the NBC Reconnaissance Systems, U.S. Army Chemical and Biological Defense Command (CBDCOM), Edgewood, Maryland, stated that the Fox is not optimized for vapor detection.<sup>30</sup> This means that the Fox does not do well at detecting a small presence of chemical warfare agent in the air. In fact, he stated that while using the vapor detection method, human symptoms would most likely appear before the Fox reconnaissance vehicle would alert.<sup>31</sup> In any event, there were no casualties from chemical warfare agent contact reported although the entire Division moved through the breach lanes without wearing gloves or masks.

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<sup>27</sup> Lead Sheet 735, p. 7, Interview of 1st Marine Division NBC Officer, June 21, 1996.

<sup>28</sup> Letter statement of Task Force Ripper Fox crew member, "Possible Chemical Weapons Use During Desert Storm," December 22, 1993.

<sup>29</sup> Testimony of Mr. James Kenny, Task Force Ripper Fox MM-1 Operator, to the Presidential Advisory Committee, May 7, 1997.

<sup>30</sup> Lead Sheet 764, Interview with Fox expert, CBDCOM, May 20, 1996. This is because the air volume drawn through the sampling tube is approximately 300 times LESS than in other detectors, such as the M8A1 designed specifically for vapor detection.

<sup>31</sup> Lead Sheet 748, Interview with CBDCOM Subject Matter Expert, April 30, 1996.

## ***Assessment***

Based on the information available thus far in this investigation, the presence of a chemical warfare agent in this area of the minefield is judged to be "Unlikely." Although two members of the Fox crew believe that their mass spectrometer detected something, the MM-1 did not sound an alarm--indicating that the computer did not find a chemical warfare agent presence at sufficient intensities to do so. There was also no effort at the time to notify the troops to go to a higher protective posture, and no follow-up or secondary confirmation. One member of the crew stated that they found nothing during the breaching operations. Senior NBC officers said that there was no report of chemical warfare agents at the time, and that there were no injuries reported despite Marines crossing the minefields protected only to the MOPP2 level. Commanders interviewed remembered no reports of chemical detection or of chemical injuries during the time the troops crossed the minefield in the 1st Marine area of operations. No means of delivery of a chemical warfare agent has been uncovered. Finally, there is no physical evidence -- no spectrum, no samples, etc.

## **Operations of the 2d Marine Division**

The 2d Marine Division attacked approximately 25 kilometers to the northwest of the 1st Marine Division (Figure 4). Under the original concept of operations, the 2d Marine Division intended to follow the 1st Marine Division through their breaching lanes. However, early analysis and walk-throughs convinced everyone that this plan would not allow the speed required for the operation nor would it minimize the exposure to enemy fire. Consequently, the 2d Marine Division's orders were changed to allow it to attack at this separate location to breach the minefield more rapidly and to generate the maximum offensive operational momentum. In this way, the 2d Marine Division could apply concentrated forces at the decisive point of attack, and "to continue rapidly forward to seize division and MEF [Marine Expeditionary Force] objectives."<sup>32</sup>

NBC guidance for the 2d Marine Division was given to the commanders in various operation plans and written orders: it warned of the possibility of a chemical attack. For example, the 2d Marine Division Operation Plan for the breaching operations directed all subordinate units to "[a]ssume all Iraqi mines, missiles, artillery and aircraft attacks to be chemical until proven otherwise."<sup>33</sup> The Fox crews were well aware of their need to detect possible chemical agents from such an attack and warn the forces, but they were still under direction to maintain the tactical momentum through the minefields. As a result, "it was obvious ... from the very beginning ... that it would not be possible for any

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<sup>32</sup> "U.S. Marines in the Persian Gulf, 1990-1991: With the 2d Marine Division in Desert Shield and Desert Storm," History and Museums Division, Headquarters, U.S. Marine Corps, Washington D.C., 1993, pp. 30-31.

<sup>33</sup> Appendix 2, NBC Defense, to Annex C to 6th MARDIV OPORD 1 91, 18 Feb 1991, pp. C-2-3 - C-2-5.

Fox under fire to stop and complete the entire testing/sampling process necessary to confirm any agent findings.”<sup>34</sup>

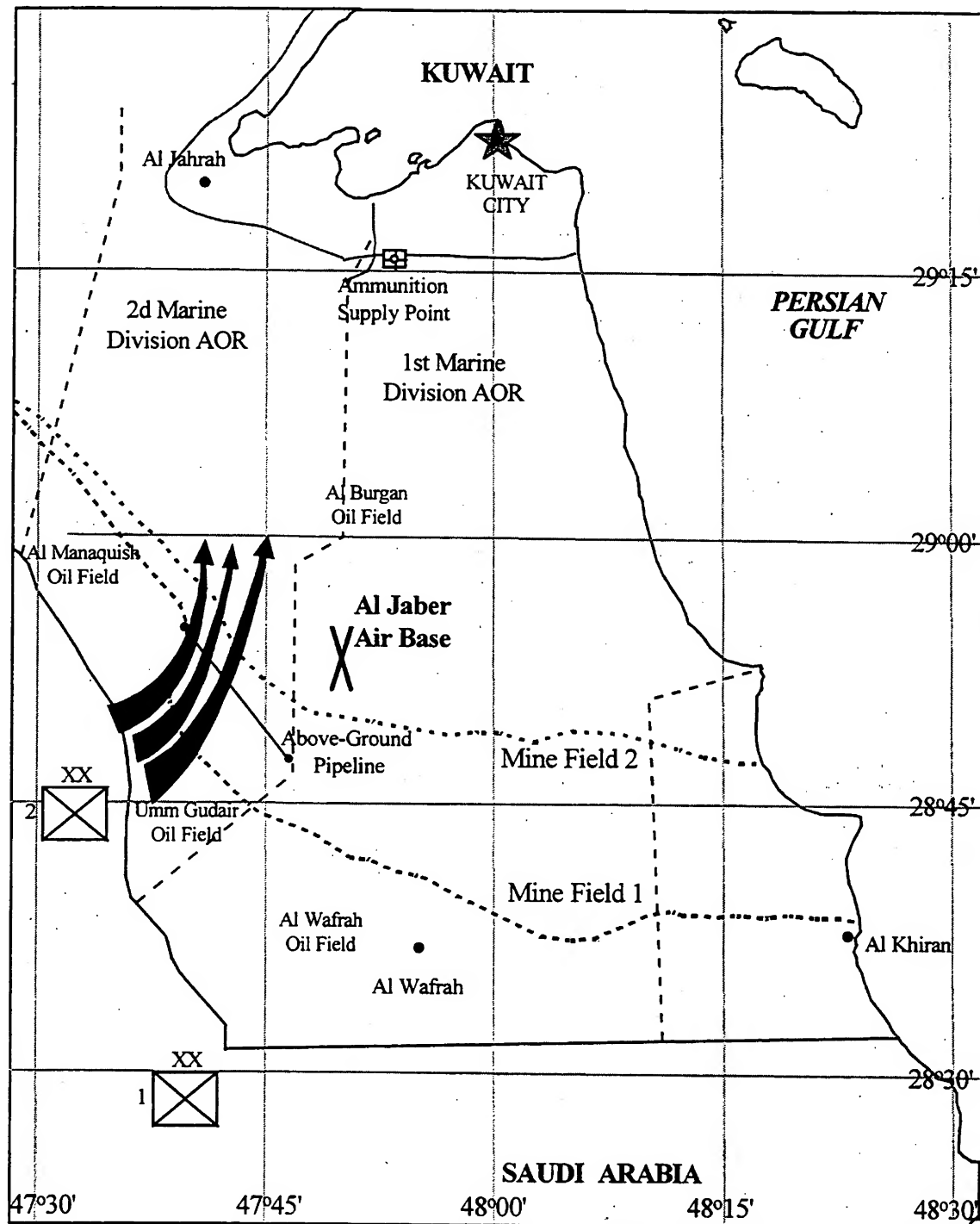


Figure 4. 2d Marine Division Minefield Breaching

<sup>34</sup> Testimony, MSgt Michael Bradford, 1st Battalion, 6th Marines Fox Vehicle Commander, to Presidential Advisory Committee, May 7, 1997.

The Commanding General's guidance to the 2d Marine Division, as reiterated in the 6th Marines Fragmentary Order, was:

The enemy has and will use chemical weapons. Unit commanders should expect to encounter the use of chemical weapons, but should not become consumed with chemical survival and ignore other important tasks, missions, etc. Expect a fair share of chemical casualties along with other conventional casualties. Remember, mission accomplishment is paramount, and risks must be taken if MOPP posture will prevent mission accomplishment. Let us not win the chemical survival battle and lose the tactical battle.<sup>35</sup>

The Marines of the 2d Division were briefed to expect chemical mines interspersed with regular mines. Company "B", 1st Armored Assault Battalion was attached to the 2d Assault Amphibian Battalion. The Commanding Officer of Company "B" recalled, "We were prepared to go to MOPP4"<sup>36</sup> (full mission protective posture that included wearing the protective mask, gloves, boots, and over-garment). As a result, the Marines in the 2d Marine Division, like their counterparts in the 1st, were primed to expect chemical attacks and well-trained to respond and fight through that eventuality.

### ***Lane Red 1 Chemical Alert***

A chemical agent alert was recounted in "U.S. Marines in the Persian Gulf, 1990-1991, With the Second Marine Division in Desert Shield and Desert Storm," published by the History and Museums Division, Headquarters, U.S. Marine Corps, and herein referred as "Second Division Monograph." This document is often referenced as proof of chemical agent use during the war. It mentions a chemical detection by a Fox reconnaissance vehicle on the first day of the ground war: "a Fox chemical reconnaissance vehicle at lane Red 1, detected a 'trace' of mustard gas, originally thought to be from a chemical mine."<sup>37</sup>

### ***Corroborating Information***

The 1st Battalion, 6th Marine Regiment (1/6) was one of the maneuver elements of the 2d Marine Division and was the source for this report of chemical agents encountered during breaching operations.<sup>38</sup> The 1/6 was reinforced by Company "C", 8th Tank Battalion and Company "B" which was attached to the 1st Armored Assault Battalion,

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<sup>35</sup> 6th Marine Regiment Appendix 2 (NBC) to Annex C (Operations) to FragO 11-91, 221200C Feb 91.

<sup>36</sup> Interview, Commanding Officer, Company "B", 1st Armored Assault Battalion, 2d Assault Amphibian Battalion, February 19, 1997, p. 29.

<sup>37</sup> "U.S. Marines in the Persian Gulf, 1990-1991: With the 2d Marine Division in Desert Shield and Desert Storm," History and Museums Division, Headquarters, U.S. Marine Corps, Washington D.C., 1993, p. 45.

<sup>38</sup> Interview, 1/6 Fox reconnaissance vehicle Commander, February 19, 1997, p. 6.



2d Assault Amphibian Battalion. The reinforced battalion was assigned the far west flank with lane Red 1<sup>39</sup> as its breach lane through the Iraqi minefields. Additionally, there were to be two return lanes to enable equipment and personnel to be evacuated to the rear without interfering with the advance -- one lane to the left and one to the right of the six assault lanes.

As in the 1st Marine Division, personnel in the 2d Marine Division began breaching operations outfitted in MOPP2. The morning started with a light mist but cleared as the day progressed.<sup>40</sup> It was cold (cold enough that "nobody complained"<sup>41</sup> about traveling in MOPP2). The sun was obscured through most of the day by burning oil smoke. In fact, the burning oil wells were close enough to lane Red 1 that when navigation hardware failed, the 1/6 "B" Company Commanding Officer directed the driver to align on and steer toward the burning oil well that was only about 100 meters from the exit point of the breach lane.<sup>42</sup>

The 1/6 had a Fox vehicle assigned in direct support. This Fox reconnaissance vehicle joined the 1/6 on February 17, 1991, just one week prior to the actual attack.<sup>43</sup> As the 1/6 Fox reconnaissance vehicle crossed the first minefield, its MM-1 operator was observing little activity on his screen. About halfway across the minefield, the MM-1 alerted to the possible presence of chemicals, so the Fox reconnaissance vehicle Commander, MSgt (then GySgt) Michael Bradford, announced "gas, gas, gas" over the battalion communications net and filed an NBC-4 report for suspected contamination. The 6th Marines Regimental listing of significant events reflects an initial report at 0631 hours followed at 0635 hours with identification of the suspected chemical agents as "Sarin nerve agent and Lewisite mustard [sic] gas."<sup>44</sup> The 1st Platoon Commanding Officer of "B" company, 1st Assault Amphibian Battalion placed the time at approximately 0630 hours and remembered the Fox reported traces of both non-persistent nerve agents and persistent blister agents.<sup>45</sup> The 1/6 NBC officer recorded the event at 0634<sup>46</sup> hours while the 2d Marine Division NBC platoon at the combat operations center recorded the report as an NBC-1 (thus changing the reconnaissance report to an attack report) at 0658 hours.

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<sup>39</sup> Breaching lanes for the 2d Marine Division were assigned with names like the Marines would use during beaching operations -- left to right (west to east), lanes Red 1, Red 2, Blue 3, Blue 4, Green 5, and Green 6.

<sup>40</sup> Interview NCOIC, NBC Decon and Chemical Casualty Team, 1st Battalion, 6th Marines, February 20, 1997, p. 35.

<sup>41</sup> Lead Sheet 1211, Interview with corporal of weapons team of 1st Platoon, "B" Company, 2d Assault Amphibian Battalion, January 9, 1997.

<sup>42</sup> Interview, Commanding Officer, Company "B," 1st Battalion, 6th Marines, May 8, 1997, pp. 10-11.

<sup>43</sup> 1/6 Command Chronology, NBC section.

<sup>44</sup> 6th Marine Regiment (-)(Rein) Sequential Listing of Significant Events - Operation Desert Storm, February 23, 1991.

<sup>45</sup> Memo from 1st Platoon Commanding Officer, "B" Company 1st Armored Assault Battalion, 2d Assault Amphibian Battalion to "B" Company Commanding Officer 1st Armored Assault Battalion, 2d Assault Amphibian Battalion, April 2, 1991.

<sup>46</sup> Marine Note known as a Yellow Canary, 1st Battalion, 6th Marines, February 24, 1991.

At 1150 hours, 2d Marine Division sent NBC-1 messages to I MEF.<sup>47</sup> This report was relayed by many units. For example, the 7th Marines in the 1st Marine Division recorded the event at 0714 hours<sup>48</sup> and even the XVIII Airborne (ABN) Corps Main far west of the Marines was informed of the incident by the XVIII ABN Corps Rear at 0955 hours.<sup>49</sup> Based on the warning from the 1/6 Fox vehicle, personnel of the 1/6 in lane Red 1 donned their chemical protective masks and gloves (MOPP 4). Although these reports are well-documented, the possible source of the suspected chemical agent is not established. NBC officers in other breach lanes evaluated the wind (blowing away from their breach lanes) and recommended that increasing MOPP level for their personnel was not warranted.<sup>50</sup>

### *Possible Chemical Land Mine*

MSgt Bradford stated that because there were both nerve and blister chemical alerts (without any enemy activity), he deduced that the agents were released by two land mines detonated by the line charges<sup>51</sup> and he reported it that way in his NBC-4<sup>52</sup> report. However, the Fox reconnaissance vehicle was not the first vehicle through breach lane Red 1. MSgt Bradford remembered that his vehicle was about the fifth one through the breach.<sup>53</sup> After combat engineers exploded a path through the minefield, the plows proofed the lane (standard procedure before the Fox or any other vehicle would enter the lane) and were followed by security personnel of "B" Company, 1st Armored Assault Battalion, who traversed the lane ahead of the Fox. According to testimony of a corporal of the 1st Platoon of "B" Company<sup>54</sup> (and corroborated by a personal audio tape recorded at the time), his unit had almost reached the area between the minefields near the above-ground pipeline before the "gas" warning was sounded. During their crossing, this corporal recounted that his vehicle was open, many personnel were standing up (only in MOPP2) looking out the open hatches, and no one experienced any symptoms of contact with a chemical agent. Also, none of the M9 chemical detector paper that they had strapped to their arms and legs recorded any contact with a liquid chemical.

MSgt Bradford said that the Fox reconnaissance vehicle itself did not hit a mine. According to him, there were no other explosions (no artillery attack) except for the explosions that occurred when the minefield was initially breached. (The Marines did receive artillery fire while breaching the second minefield which was more heavily

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<sup>47</sup> Journal, 2d Marine Division, February 24, 1991.

<sup>48</sup> "Breaching Operations, 7th Marines Log", February 24, 1991.

<sup>49</sup> U.S. Army, Message Form, Subject: MARCENT Report, 240955C Feb 91.

<sup>50</sup> Interview, 1/6 NBC Officer, February 19, 1997, pp. 24, 25.

<sup>51</sup> Interview, MSgt Bradford, 1/6 Fox reconnaissance vehicle Commander, February 19, 1997, p. 13.

<sup>52</sup> He chose an NBC-4 report instead of an NBC-1 report because they were not under attack, so the report was more accurately an observation of a possibly contaminated area. Interview, MSgt Bradford, 1/6 Fox reconnaissance vehicle Commander, February 19, 1997, pp. 6-7.

<sup>53</sup> Lead Sheet 577, pp. 17-18, Interview, MSgt Bradford, 1/6 Fox reconnaissance vehicle Commander, December 19, 1996.

<sup>54</sup> Lead sheet 1211, Interview with a corporal of the weapons team of 1st Platoon, "B" Company, 1st Armored Assault Battalion, January 9, 1997.

defended, but that was hours later.) He stated that they were sampling with the chemical sampling wheels down, moving fast, and that the area was dirty with oil and residue. There were pools of oil and dirty sand all around.<sup>55</sup> This is significant because the Fox reconnaissance vehicle may incorrectly alert to a chemical warfare agent in an environment of heavy concentrations of petroleum-based hydrocarbons.<sup>56</sup>

In the evening of the first day when the offensive paused, the Fox was sampling the air but receiving no indications of chemical warfare agent vapors. The crew left the vehicle and used a Chemical Agent Monitor to check their vehicle for residual agents but found none,<sup>57</sup> despite the fact that both mustard and Lewisite chemical warfare agents to which their Fox alerted are persistent. The crew also checked other vehicles that had passed through their breach and none showed any signs of mustard or Lewisite. One shrapnel hole did register a 2-bar reading for a G-series nerve agent. In the morning, the hole did not register anything.

In another report of a possible chemical mine, the 2d Assault Amphibian Battalion Command Chronology states that a 2d Assault Amphibian Battalion vehicle hit two anti-tank mines and a chemical mine.<sup>58</sup> The Commanding Officer of Company "B", 1st Armored Assault Battalion, which was attached to the 2d Assault Amphibian Battalion, confirmed that he had lost an Amtrac vehicle because of damage caused by running over a landmine, but he did not believe they were chemical mines, and he does not remember how or why the entry was made in the Command Chronology.<sup>59</sup> In addition, he and his personnel in the Amtrac dismounted and walked out of the minefield breach in MOPP2 with no effects that would imply contact with chemical warfare agents.

In the ensuing investigation of this incident, available operational reports and interviews with Explosive Ordnance Disposal (EOD) experts disclosed that they found no chemical mines. In fact, no chemical mines have been recovered from this or any other minefield of the war. One EOD expert, who cleared minefields in Kuwait both during the war and after the war as a contractor for the Kuwait government, reported that he never encountered a chemical mine and that he knew of no chemical mines being found in this area of operations.<sup>60</sup>

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<sup>55</sup> Lead Sheet 577, Interview, MSgt Bradford, 1/6 Fox reconnaissance vehicle Commander, December 19, 1996.

<sup>56</sup> Testimony, Fox Subject Matter Expert, Mr. Richard Vigus, CBDCOM, before the Oversight and Investigations Subcommittee of the Committee on Armed Services, U.S. House of Representatives, November 18, 1993, p. 41.

<sup>57</sup> Interview, 1/6 Fox Reconnaissance Vehicle Commander, February 19, 1997, pp. 31-32.

<sup>58</sup> "Command Chronology for Period of 1 February to 28 February 1991," 2d Assault Amphibian Battalion, p. 4.

<sup>59</sup> Interview, Commanding Officer of Company "B", 1st Armored Assault Battalion, 2d Assault Amphibian Battalion, February 19, 1997, p. 34.

<sup>60</sup> Lead Sheet 762, Interview with EOD expert, May 17, 1996.

Mine-clearing operations after the war cleared over 341,064<sup>61</sup> mines without encountering any chemical mines. The process for identifying and clearing ordnance from Kuwait Theater of Operations (KTO) was both rigorous and detailed, unlike the more rushed destructions at Khamisiyah. It started with subdividing the area into 36 sections of about 80 square kilometers each. Within each section, skilled EOD teams, using global positioning equipment and computers, identified the location and type of explosive ordnance. Using this inventory, disposal teams then moved through each sector, collected the ordnance into large berm-enclosed pits, and implosion-detonated the contents. These pits were reused repeatedly by EOD experts who wore no special protective clothing and who suffered no effects of contact with chemical warfare agents. Throughout these clearance operations in the U.S. sector, chemical warfare agents were never detected.<sup>62</sup> CMS, Inc. is one company that cleared munitions and unexploded ordnance from the U.S. sector of the KTO after the war. The president of the company's division responsible for these efforts stated that in the 3 years that they cleared munitions, they never found any chemical mines in Kuwait. They also met regularly with the Kuwaiti Ministry of Defense and the contractors clearing the other areas of the KTO. No one in any of those meetings reported discovering a chemical mine in Kuwait.<sup>63</sup> Finally, Iraq has not turned over any chemical mines nor declared research on chemical mines to UNSCOM.

### *Fox Alert Analysis*

The 1/6 Fox reconnaissance vehicle Commander, MSgt Bradford, was alerted by the MM-1 operator to the possible chemical presence in the first minefield. The printout tape<sup>64</sup> from this Fox's operation documents alerts for Sarin, HQ Mustard, and Lewisite<sup>65</sup> chemical warfare agents. Responding to these alerts, the Fox crew took the correct proactive action and warned the 1/6 of the possible presence of chemical warfare agents. However, a detailed examination of each alert tape shows "Fat, Oil, Wax" at higher intensities than each chemical warfare agent. "Fat, Oil, Wax" is an indication of a false alarm due to battlefield contaminants. (Figure 5.)

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<sup>61</sup> DIA Intelligence Information Report, June 2, 1997, Subject: "Iraqi Ordnance Clean-up Operations in Kuwait"

<sup>62</sup> DIA Intelligence Information Report, June 2, 1997, Subject: "Iraqi Ordnance Clean-up Operations in Kuwait"

<sup>63</sup> Lead Sheet 1288, Interview with CMS, Inc. Division President, February 11 and 12, 1997.

<sup>64</sup> The Fox has the capability to print a list of ion masses and intensities that represent what is shown on the MM-1 operator's screen to a tape for later analysis.

<sup>65</sup> In the operational evaluation of the Fox conducted after the war, the Fox was shown to false alarm with a Lewisite alert due to chemicals given off by its silicon wheels. NBC Defense Program Manager Memorandum, Subject: "Results of the Combat Systems Test Activity (CSTA) MM-1 Excursion Test," July 14, 1993.

The first alarm occurred at 0621 hours when the MM-1 alerted to "Fat, Oil, Wax." A minute later, a second alert occurred for "Fat, Oil, Wax" but this time the MM-1 indicated that there might have been Lewisite present. Because the Fox reconnaissance vehicle

makes its initial detection using only four ions of the entire spectrum of a chemical warfare agent, it can sound a false alarm due to similar ion patterns from interfering chemicals. Only the second step of the Fox two-step confirmation process can evaluate the entire spectrum and compare it to the library of known chemical warfare agents.

AIR MONITOR			
4827/3419	06:21	11	
FAT,OIL,WAX		A 4.5	
4852/3471	06:22	12	
FAT,OIL,WAX		A 4.9	
LEWISITE		(L) A 2.9	
4854/3474	06:22	13	
SPECTRUM			
FAT,OIL,WAX		S 4.8	
	06:23	14	
FAT,OIL,WAX		A 5.7	
SARIN		(GB) A 5.1	
	06:23	15	
FAT,OIL,WAX		A 5.7	
SARIN		(GB) A 5.1	
	06:23	16	
FAT,OIL,WAX		A 5.4	
HQ-MUSTARD		(HQ) A 4.2	
	06:24	17	
FAT,OIL,WAX		A 5.0	
	06:25	18	
FAT,OIL,WAX		A 4.9	
	06:26	19	
SPECTRUM			
FAT,OIL,WAX		S 4.4	
	06:26	20	
FAT,OIL,WAX		A 4.6	
BACKGROUND			
V CWA WHEEL/HI			
4867/3507	06:27	21	
SPECTRUM			
FAT,OIL,WAX		S 4.3	
4870/3512	06:31	22	
HQ-MUSTARD		(HQ) A 3.8	
	06:32	23	
SPECTRUM			
FAT,OIL,WAX		S 4.5	

Figure 5. Lane Red 1  
Fox Tape

Following their procedures, the Fox crew took a spectrum with its MM-1, although they did not change the method of detection to a lower temperature to discriminate better among the substances detected, nor did they stop since they were in the middle of a combat operation. The spectrum showed only "Fat, Oil, Wax," which means the sample was contaminated with hydrocarbons. More alerts followed from 0623 hours to 0626 hours, again primarily for "Fat, Oil, Wax," but with the possibility of Sarin or HQ-Mustard. Again the crew ran a spectrum and again the spectrum showed only "Fat, Oil, Wax." Spectrums run at 0627 hours and 0632 hours also showed only "Fat, Oil, Wax." From 0635 hours to 0637 hours, the MM-1 printed "HQ-Mustard," but showed that no spectrum was run during these times.

The tape that recorded the Fox's MM-1 results was provided to the US Army's Chemical and Biological Defense Command (CBDCOM) for analysis.<sup>66</sup> CBDCOM determined that although the procedures used by the Fox may have been appropriate for the operational situation, they were incomplete to confirm the presence of chemical warfare agents. First, the sample was obtained using vapor sampling. Although the Fox was using the wheel method, the tape clearly shows that it was an air sample that generated the alarm, not a liquid substance vaporized off a sampler wheel. Using the vapor sampling method, the MM-1 is far less sensitive than other detectors.<sup>67</sup>

<sup>66</sup> NBC Defense Program Manager Memorandum, Subject: "Analysis of Fox MM-1 Tapes," March 3, 1997.

<sup>67</sup> Lead Sheet 3858, CBDCOM MM-1 Subject Area Expert, April 17, 1997.

Second, the MM-1 detected "Fat, Oil, Wax" throughout the time of the alerts and always in higher relative intensities than any suspected chemical agent. This response indicates a high level of interfering hydrocarbons was present at that time, which is consistent with eyewitness reports of smoke and oil in the air from the oilwell fires. "Under circumstances of high interferent concentrations, the MM-1 is prone to responding with incorrect initial alarms for other compounds being monitored."<sup>68</sup>

The National Institute of Standards and Technology (NIST) also evaluated the Fox tape and concluded that the "high relative concentrations of 'Fat, Oil, Wax' probably led to a false identification."<sup>69</sup> Similarly, Bruker Daltonics, a nationally renowned expert on the Fox reconnaissance vehicle, analyzed the tape and concluded that the "information in the tapes is consistent with the background information of driving through an area with large amounts of oil in the background."<sup>70</sup> To determine if chemical agents were present as well as the "Fat, Oil, Wax," the MM-1 operator would have had to perform special additional spectrum analyses following the normal spectrum. However, U.S. military personnel were not taught to perform these special spectrum techniques<sup>71</sup> during their training courses.

Although the detections were printed to the Fox tape, the results of the spectrum were not. Apparently, the Fox was not operating with the "auto print" feature engaged and the operator did not depress the print button to print the ion pattern of the spectrum onto the Fox tape. Consequently, it is not possible to determine what the operators saw on the screen. As a result, the actual ion pattern that could have provided details of the chemicals detected does not exist. The CBDCOM Fox experts concluded that "because of the presence of high concentrations of interferents and the short time span between these responses, we conclude that the presence of the three chemical warfare compounds is highly unlikely."<sup>72</sup> NIST also pointed out that the "detection of three quite different agents ... is consistent with false indications from a high, variable, and complex background signal."<sup>73</sup> Bruker states the same conclusions somewhat differently: "it is typical that as you drive through a contaminated area, the intensity of the alarm goes up, reaches a maximum, and then goes down as you leave the area. A single alarm for an agent is not consistent with driving through an area of contamination."<sup>74</sup> Due to the priorities of war, the Fox did not stop to take samples, perform any M256 tests, or

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<sup>68</sup> NBC Defense Program Manager Memorandum, Subject: "Analysis of Fox MM-1 Tapes," March 3, 1997.

<sup>69</sup> Letter, National Institute of Standards and Technology, June 16, 1997.

<sup>70</sup> Letter, Bruker Daltonics, Subject: "Analysis of MM-1 Data," July 15, 1997.

<sup>71</sup> "Fox Reconnaissance Vehicle," Information Paper, July 31, 1997.

<sup>72</sup> NBC Defense Program Manager Memorandum, Subject: "Analysis of Fox MM-1 Tapes," March 3, 1997.

<sup>73</sup> Letter, National Institute of Standards and Technology, June 16, 1997, CMAT Control # 1997168-0000-303.

<sup>74</sup> Letter, Bruker Daltonics, Subject: "Analysis of MM-1 Data," July 15, 1997.

identify contaminated areas. The absence of these actions precludes other possible sources of confirmation of the presence of chemical warfare agents.

The commanding officer of the 1st Battalion, 6th Marines, stated that the detection, as reported to him in the NBC report, was a trace amount, and he understood that the Fox did not get a full-spectrum readout.<sup>75</sup> He stated that all personnel in the possibly-affected units went to MOPP4 when the alarm sounded and the NBC officer alerted other units that lane Red 1 may have been contaminated for the first 300 meters. 2d Marine Division units were directed to continue to monitor the condition of lane Red 1 for the next several hours.<sup>76</sup> Since there were only trace alerts for vapor, no secondary indications of chemical attack, no reports from other nearby units, and no injuries or anything else that would substantiate a chemical incident, he considered the event a false alarm.<sup>77</sup>

The "Second Division Monograph" also states that "a second Fox vehicle was dispatched to the area and confirmed the presence of an agent which had probably been there a long time."<sup>78</sup> Although the "Second Division Monograph" is a widely referenced text, the author begins with a warning:

This history is intended to be a first effort ... and [researchers will need] to balance what is written here against those more complete records which will be available to them, and they will be able to correct any errors of fact, which may have been made.<sup>79</sup>

More to the point is whether a second Fox reconnaissance vehicle was sent to the site of the chemical alert and "confirmed" the presence of a chemical agent. The author credits this account of the second Fox to the 2d Marine Division NBC officer. The 2d Marine Division NBC officer was an experienced NBC specialist (5702 MOS) and was situated in the command post as the Commanding General's staff officer for NBC operations. He was considered knowledgeable about chemical attack defenses, detection and reporting procedures, and would have been aware of the employment of the Fox reconnaissance vehicles in his division.

This 2d Marine Division NBC officer denied the report in the monograph.<sup>80</sup> He remembered that the Fox vehicles were dispersed throughout the I MEF, with vehicles assigned to each division. Each of the vehicles assigned to the 2d Marine Division was

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<sup>75</sup> Lead Sheet 577, pp. 5-7, Interview with 1st Battalion 6th Marines Commanding Officer, March 7, 1996.

<sup>76</sup> 6th Marine Regiment (-)(Rein) Sequential Listing of Significant Events - Operation Desert Storm, February 24, 1991.

<sup>77</sup> Lead Sheet 577, pp. 5-7, Interview with 1st Battalion 6th Marines Commanding Officer, April 4, 1996.

<sup>78</sup> "U.S. Marines in the Persian Gulf, 1990-1991: With the 2d Marine Division in Desert Shield and Desert Storm," History and Museums Division, Headquarters, U.S. Marine Corps, Washington D.C., 1993, p. 45.

<sup>79</sup> "U.S. Marines in the Persian Gulf, 1990-1991: With the 2d Marine Division in Desert Shield and Desert Storm," History and Museums Division, Headquarters, U.S. Marine Corps, Washington D.C., 1993, Preface.

<sup>80</sup> Lead Sheet 577, pp. 11&12, Interview with 2d Marine Division NBC Officer, March 12, 1996.

further assigned to support a maneuver unit passing through the minefield breaches.<sup>81</sup> Each vehicle maintained its pre-assigned lane within its maneuver unit and pressed on with the attack through the minefields. He stated that no other Fox reconnaissance vehicle was dispatched to lane Red 1 to "confirm" the alert. His statement is supported by the 1/6 NBC officer who reiterated that a second Fox vehicle was never sent to follow-up the initial lane Red 1 alert.<sup>82</sup> Also, if there had been another Fox alert at the location, there should have been another NBC report. In this case, however, there is no record of a second report of the presence or absence of the suspected agents. The I MEF NBC officer who was in a position to know of all NBC events in the Marine divisions stated that "during my whole time over there, I never knew of any confirmed NBC-1 report."<sup>83</sup>

There was, however, an individual who claimed that the 8th Marines picked up readings of nerve agents when they passed through the breach lanes on the second day of the ground war (G+1).<sup>84</sup> The 8th Marines breached through lane Red 2. However, the Command Chronology for the 8th Marines does not mention any chemical warfare agent detection in the breach lanes on G+1.<sup>85</sup>

### *Possible Chemical Injury*

The "Second Division Monograph" also says the chemical agent was "sufficiently strong to cause the blistering on the exposed arms of two AAV [Assault Amphibian Vehicle] crewmen."<sup>86</sup> This has been a point of particular interest and investigation, but only one Marine has claimed to have been injured by chemical warfare agents during breaching operations.<sup>87</sup>

The day started cool and misty and the Marines were wearing their protective overgarments (MOPP2). Consequently, it is unlikely that anyone would have had "exposed arms," but hands would have been exposed at MOPP2. The 2d Marine Division NBC Officer would have been one of the first people to become aware of any NBC injuries, and he stated no such injuries were reported up to the Division level.<sup>88</sup> Further, he stated that every service member was aware of the potential for Iraqi use of chemical weapons

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<sup>81</sup> The four Fox reconnaissance vehicles in the 2d Marine Division were assigned to the 6th Marines, 8th Marines, the Tiger Brigade, and the Division headquarters, Interview, 2d Marine Division NBC Platoon Commander by I MEF Battle Assessment Team NBC Officer, March 20, 1997, p. 1.

<sup>82</sup> Interview, 1st Battalion, 6th Marines NBC Officer, February 19, 1997, p. 19.

<sup>83</sup> Interview, I MEF NBC Officer, February 19, 1997, p. 7.

<sup>84</sup> Interview, 2d Marine Division NBC Platoon Commander by I MEF Battle Assessment Team NBC Officer, March 20, 1991, pp 1&2.

<sup>85</sup> "Command Chronology for 1 February to 28 February 1991," 8th Marines, 2d Marine Division, March 14, 1991.

<sup>86</sup> "U.S. Marines in the Persian Gulf, 1990-1991: With the 2d Marine Division in Desert Shield and Desert Storm," History and Museums Division, Headquarters, U.S. Marine Corps, Washington D.C., 1993, p. 45.

<sup>87</sup> A second Marine may have been injured by chemical agents after the war, but his case will be investigated separately.

<sup>88</sup> Lead Sheet 577, p. 11&12, Interview with 2d Marine Division NBC Officer, March 7, 1996.



and trained how to respond, continue fighting, and report. Any suspected chemical injuries should have surfaced.

Personnel records of 1/6, including the supporting reinforcements, show only two wounded in action for 24-25 February 1991--both gunshot wounds.<sup>89</sup> Additionally, Marine Corps casualty records show no chemical wounds were reported. There were no chemical-related deaths and no purple hearts awarded by the Marine Corps during Operation Desert Shield or Desert Storm for any chemical injuries.<sup>90</sup>

In a written statement, the 1/6 Commanding Officer said,

There were no indications from Marines that the alert was in fact positive. I aggressively pursued any potential medical problems associated with the attack and saw absolutely no evidence of any.... I feel confident that any chemical attack in our sector would have surfaced. I can categorically state that no one came forward and stated/claimed any evidence of medical problems resulting from chemical and /or biological weapons.<sup>91</sup>

After hearing rumors of the injury, the 1/6 Battalion Commanding Officer tried to find a member of his battalion who showed any signs of chemical injury. He searched throughout his battalion, including those reinforcements that were assigned to him for the breaching operation and units that remained with him for a month after the cease-fire in Kuwait. He found no one.<sup>92</sup>

However, a platoon Commanding Officer did recommend a Purple Heart for a Marine after the cease-fire. This Marine was a member of the 1st Platoon, Company B, 1st Armored Assault Battalion, attached to the 2d Amphibian Assault Battalion. He was in a vehicle that followed the Fox vehicle through the lane Red 1 breach. In a written statement, the Marine reported that immediately after the breaching charge, the tactical network reported "gas," so he put on his mask (but not his gloves), closed up the vehicle, and in doing so, exposed his hands to the outside air. He reported that immediately he felt a strong burning sensation and blisters began forming.<sup>93</sup> Immediate pain is consistent with contact with the blister agent Lewisite, but no evidence of Lewisite was ever found in the KTO, nor has any significant evidence surfaced that the Iraqis had Lewisite in their inventory. Neither Lewisite or HQ Mustard would produce immediate blisters.<sup>94</sup> UNSCOM does not list Lewisite or HQ Mustard as part of Iraq's inventory even after 6 years of investigations.

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<sup>89</sup> Personnel Status Report, 6th Marine Regiment, 1200 24 February to 1200 25 February 1991.

<sup>90</sup> Memorandum, Marine Corps Casualty Section, Subject: "Chemical Casualties During Desert Shield/Desert Storm," March 11, 1996.

<sup>91</sup> Lead Sheet 577, pp. 5-7, Statement of 1/6 Commanding Officer, June 13, 1994.

<sup>92</sup> Lead Sheet 577, pp. 5-7, Interview of 1/6 Commanding Officer, April 4, 1996.

<sup>93</sup> Statement of Injured Marine, January 14, 1992.

<sup>94</sup> U.S. Army FM 3-9 U.S. Navy NAVFAC Publication P-467 U.S. Air Force Manual 355-7, "Potential Military Chemical/Biological Agents and Compounds," December 12, 1990, pp. 38-41.

Although all Marines in the vehicle were in MOPP2 before the warning, no one else reported any of these symptoms. Also, this Marine was in an Amtrac that was following the Fox reconnaissance vehicle. His vehicle had not yet entered the minefield breach lanes when he heard the Fox report gas. The injured Marine indicated that his vehicle was about tenth in line to pass through the breach with 50 meters of separation between vehicles;<sup>95</sup> the Fox was fifth, and the 1/6 Company Commander stated the breach was only about 70 meters deep.<sup>96</sup>

In an earlier interview,<sup>97</sup> this Marine stated that after closing up the vehicle, he felt a burning sensation on the back of his right hand under his glove. He removed the glove, decontaminated the back of his hand with materials from his M258 kit, and put the glove back on. When his unit arrived at the end of the first breach lane, they were informed that they could return to MOPP2, at which time he noticed small eraser-sized blisters on both hands. Again, he decontaminated. He stated that later the Fox Commander checked his hands and attributed the blisters to a low-level blister agent, but it was not Lewisite. The Fox reconnaissance vehicle Commander remembers looking at the man's hands, seeing that they were red, but without blisters, and commenting that if it were a chemical reaction, it must have been from a minute quantity,<sup>98</sup> but he did not interpret the condition as a chemical injury on the basis of his quick viewing.

Other Marines who saw the Marine's injuries gave differing observations. His platoon sergeant saw his hands a day or so after the event and remembers only redness, no blisters.<sup>99</sup> The company Commanding Officer remembers meeting the Marine several days after the event and seeing only one hand, the back of which was reddish with three small pea-sized blisters.<sup>100</sup> Another eyewitness who accompanied the Marine to the battalion aid station about 12 hours after the event, stated that he saw what may have been a burn-like area on the back of the individual's right hand. There were no blisters, just reddening, complicated by black charcoal powder from the MOPP suit. The red area was about the size of a silver dollar and it appeared to have been scratched.<sup>101</sup> The Fox reconnaissance vehicle Commander, who checked the Marine's injury, said "I wouldn't even really call it an injury as much as the fact that it was still red, irritated, and he had been scratching it."<sup>102</sup> However, the injured Marine's platoon Commanding Officer

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<sup>95</sup> Interview, Injured Marine, February 19, 1997.

<sup>96</sup> Interview, Commanding Officer, "B" Company, 1st Battalion, 6th Marines, May 8, 1997.

<sup>97</sup> Interview of Injured Marine by I MEF Battle Assessment Team NBC Officer, March 19, 1991.

<sup>98</sup> Interview of MSgt Bradford, 1/6 Fox reconnaissance vehicle Commander, February 19, 1997, pp. 22-25.

<sup>99</sup> Interview of Platoon Sergeant, "B" Company, 1st Armored Assault Battalion, 2d Assault Amphibian Battalion, February 19, 1997, pp. 9-10.

<sup>100</sup> Interview of Commanding Officer, "B" Company, 1st Armored Assault Battalion, 2d Assault Amphibian Battalion, February 19, 1997, pp. 15, 21.

<sup>101</sup> Interview of Staff NCOIC, NBC Decon and Chemical Casualty Team, 1st Battalion, 6th Marines, pp. 23-25.

<sup>102</sup> Interview of 1/6 Fox reconnaissance vehicle Commander, February 19, 1997, p. 22.

stated that at the end of the day, he saw blisters on the Marine's left hand.<sup>103</sup> The senior corpsman of the 1/6 saw the Marine the next morning but he could not examine the Marine's hands because they were bandaged, although he reported that he saw what may have been the "signs of blisters" a week later.<sup>104</sup> Although the observations differ, they seem to agree that the possible injured area was limited to small areas on the backs of the hands. He wore no gloves, but there were apparently no blisters on the palms of his hands, on the fingers, or between the fingers.

The Marine did visit the battalion aid station in the evening after the completion of the breaching operations. One eyewitness remembers the corpsmen and the doctors discussing the possibilities of the cause of the visit to be chemical contamination. One corpsman who examined the Marine's hand stated that he saw an area about the size of a quarter that appeared to be blistered, but it didn't appear to be a chemical injury.<sup>105</sup> The medical officer who examined the Marine remembers him well as the only person who complained of any kind of a chemical injury,<sup>106</sup> but he doubted the hand was injured by chemical warfare agents. His official evaluation was more explicit:

I found no blistering. I returned the [individual] to full duty without any treatment necessary....<sup>107</sup>

Two weeks after the cease fire, an I MEF Battle Assessment Team NBC Officer interviewed the Marine and observed two blisters on the injured hand,<sup>108</sup> which he described as "classic mustard/Lewisite blister agent wounds," but this officer never reported a chemical injury. Finally, the Assault Amphibian Battalion Commanding Officer who convened a preliminary Purple Heart investigation, concluded that the injuries were not considered appropriate for a Purple Heart award<sup>109</sup> because the injury did not require treatment by a medical officer. Due to the conflicting observations, this investigation is still pursuing expert medical evaluations of the injury to the Marine.

### *Assessment*

This investigation is not complete, but based on the information available so far, the presence of a chemical warfare agent in the 2d Marine Division's area of the minefield is

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<sup>103</sup> Statement, 1st Platoon Commanding Officer, "B" Company, 1st Armored Assault Battalion, 2d Assault Amphibian Battalion, April 2, 1991.

<sup>104</sup> Statement, Corpsman, Subject: "Suspected Chemical Injury to Sgt. [Redacted]," December 18, 1991.

<sup>105</sup> Lead Sheet 3859, Interview of Corpsman, 1st Battalion, 6th Marines, April 2, 1997.

<sup>106</sup> Lead Sheet 3860, Interview of Medical Officer, 1st Battalion, 6th Marines, March 26, 1997.

<sup>107</sup> Statement, Medical Officer, 1st Battalion, 6th Marines, Subject: "Suspected Wound/Resulting from Chemical Exposure on 24 February 1991 ICO: Sgt [Redacted], USMC, [serial number]," March 4, 1992.

<sup>108</sup> E-mail Statement, I MEF Battle Assessment Team NBC Officer, January 15, 1997. He described the blisters as "classic mustard/Lewisite blister agent wounds," without any graduated skin coloration between the blisters.

<sup>109</sup> 2d Assault Amphibian Battalion, 2d Marine Division, Commanding Officer Letter, Subject: "Injuries Sustained in Combat Operations During Operation Desert Storm; Case of Sergeant (Redacted)," April 23, 1992.

judged to be "Unlikely." The alert to the possible contamination was certain, well-documented, and reported throughout the theater. The Marines in the Fox reconnaissance vehicle followed established operating procedures to get the word out to members of the 1/6 quickly, so they could change to MOPP4 for maximum protection in case the chemical detection was valid. The review of the tape produced by the Fox shows that nerve agent, and mustard and Lewisite blister agents were reported by the MM-1 during the initial scan, but in combination with "Fat, Oil, Wax"--which indicates an interferent. In fact, the area through which the Fox was traveling was thick with oil and smoke, which are known interferents to the Fox's spectrometer. Expert analyses of the tape by three independent agencies state that the Fox presented false indications. Also, despite the persistent nature of mustard and Lewisite, neither was present on any equipment or vehicles when the Marines paused after passing through the breaches. Because the troops were moving fast, the Fox reconnaissance vehicle did not stop to take a sample of the suspected contamination, so no physical evidence other than the tape exists.

The investigation has not been able to find a delivery mechanism for the suspected chemical contamination. There was no artillery or mortar fire and the assumption of chemical mines is not proven. No chemical mines were ever found during or after the war in the Kuwait theater of operations, which casts doubt on the report of chemical mines as the source. Even the commander in the Amtrac that hit a mine reported that he and his men left the vehicle in MOPP2 and none suffered from encountering a chemical warfare agent.

Several vehicles carrying Marines in MOPP2 passed through the 2d Marine Division minefields ahead of the Fox reconnaissance vehicle. Although their hands and faces were exposed, none reported any chemical injuries. The only possible chemical injury was reported by a Marine in a vehicle that followed the Fox. The eyewitnesses who saw this Marine over the next several days reported contradictory observations, with many reporting that he had a couple of blisters, but several stating they saw no such injuries. No one has been able to confirm that these possible blisters were caused by chemical agents rather than many other possible causes for blisters. The doctor who saw him the first night stated that there were no blisters and no treatment was required. This investigation is still pursuing expert medical evaluations of the Marine's injury.

***This case is still being investigated. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DOD Persian Gulf Task Force Hot Line at***

**1-800-472-6719**

## ***Tab A - Acronyms and Glossary***

### Acronyms

1/6 .....	1st Battalion, 6th Marines
1/7 .....	1st Battalion, 7th Marines
AAV .....	Assault Amphibian Vehicle
AOR .....	Area of Operations
ASP .....	Ammunition Supply Point
CBD COM .....	Chemical and Biological Defense Command
CSTA .....	Combat Systems Test Activity
CW .....	Chemical Warfare
CWO .....	Chief Warrant Officer
DIA .....	Defense Intelligence Agency
DOD .....	Department of Defense
EOD .....	Explosive Ordnance Disposal
FragO .....	Fragmentary Order
GySgt .....	Gunnery Sergeant
IAD .....	Investigation and Analysis Directorate
I MEF .....	First Marine Expeditionary Force
KTO .....	Kuwait Theater of Operations
LtGen .....	Lieutenant General
MARCENT .....	Marine Forces Central Command
MARDIV .....	Marine Division
MEF .....	Marine Expeditionary Force
MLRS .....	Multi-Launched Rocket System
MM-1 .....	Mobile Mass Spectrometer
MOPP .....	Mission-Oriented Protective Posture
MOS .....	Military Occupational Specialty
NBC .....	Nuclear, Biological, Chemical
NCOIC .....	Non-commissioned Officer-in-Charge
NIST .....	National Institute of Standards and Technology

OPORD..... Operations Order  
OpPlan..... Operations Plan  
OSAGWI.....Office of the Special Assistant for Gulf War Illnesses  
  
Sgt..... Sergeant  
  
UNSCOM ..... United Nations Special Commission on Iraq

### Glossary

#### M256 Kit Chemical

Agent Detector Kit: A portable, expendable item capable of detecting and identifying both liquid and vapor chemical agents (e.g, blister, blood, and nerve). Used to identify the types of agent present and to determine if it is safe to unmask after a suspected or known chemical attack. Ref: Worldwide Chemical Detection Equipment Handbook, p. 430.

#### M9 Chemical Agent

Detector Paper: Expendable paper used to detect liquid chemical agents. M9 paper is chemically treated on one side to react to liquid chemical agent by turning red or reddish brown, and has an adhesive back to adhere to protective garments or equipment.

***TAB B - Units Involved*****1st Marine Division**

Headquarters Battalion	
1st Marines	1st Battalion, 1st Marines 3d Battalion, 9th Marines 1st Tank Battalion
3d Marines	1st Battalion, 3d Marines 2d Battalion, 3d Marines 3d Battalion, 3d Marines
4th Marines	2d Battalion, 7th Marines 3d Battalion, 7th Marines 1st Battalion, 25th Marines
7th Marines	1st Battalion, 7th Marines 1st Battalion, 5th Marines 3d Tank Battalion
11th Marines	1st Battalion, 11th Marines 2d Battalion, 11th Marines 3d Battalion, 11th Marines 5th Battalion, 11th Marines 1st Battalion, 12th Marines 3d Battalion, 12th Marines
1st Combat Engineer Battalion 1st Light Armored Infantry Battalion 1st Reconnaissance Battalion 3d Assault Amphibian Battalion	

## 2d Marine Division

Headquarters Battalion	
6th Marines	1st Battalion, 6th Marines Company C, 8th Tank Battalion Company B, 1st Armored Assault Battalion 2d Battalion, 2d Marines Company A, 8th Tank Battalion Company B, 2d Assault Amphibian Battalion 3d Battalion, 6th Marines 8th Tank Battalion
8th Marines	1st Battalion, 8th Marines Company B, 4th Tank Battalion Company C, 2d Combat Engineer Battalion Company D, 2d Assault Amphibian Battalion 2d Battalion, 4th Marines Company C, 4th Tank Battalion Company B, 4th Assault Amphibian Battalion 3d Battalion, 23d Marines
1st Brigade (Tiger Brigade), 2d Armored Division	1st Battalion, 67th Armor 3d Battalion, 67th Armor 3d Battalion, 41st Infantry (Mechanized) 1st Battalion, 3d Field Artillery 502d Support Battalion 142d Signal Battalion Battery A, 92d Field Artillery (MLRS) Company A, 17th Engineers Company B, 4th Battalion, 5th Air Def Artillery
10th Marines	2d Battalion, 10th Marines 2d Battalion, 12th Marines 3d Battalion, 10th Marines 5th Battalion, 10th Marines
2d Light Armored Infantry Battalion 2d Reconnaissance Battalion 2d Tank Battalion 2d Combat Engineer Battalion 2d Assault Amphibian Battalion Task Force Breach Alpha Task Force Vega	



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## ***TAB D - METHODOLOGY FOR CHEMICAL INCIDENT INVESTIGATION***

The DOD requires a common framework for our investigations and assessments of chemical warfare agent incident reports, so we turned to the United Nations and the international community which had experience concerning chemical weapons. Because the modern battlefield is complex, the international community developed investigation and validation protocols<sup>110</sup> to provide objective procedures for possible chemical weapons incidents. The standard that we are using is based on these protocols that include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation, or human or animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by an expert panel.

While the DOD methodology for investigating chemical incidents (Figure 6) is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, the methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. The major efforts in this methodology are:

- Substantiate the incident.
- Document the medical reports related to the incident.
- Interview appropriate people.
- Obtain information available to external organizations.
- Assess the results.

Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

To substantiate the circumstances surrounding an incident, the investigator searches for documentation from operational, intelligence, and environmental logs. This focuses the investigation on a specific time, date, and location, clarifies the conditions under which the incident occurred, and determines whether there is "hard" as well as anecdotal evidence. Additionally, the investigator looks for physical evidence that might indicate that chemical agents were present in the vicinity of the incident, including samples (or the results of analyses of samples) collected at the time of the incident.

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<sup>110</sup> "Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction," April 29, 1997. This Chemical Weapons Convention was opened for signature in Paris, France, on January 13, 1993. It has been signed by 165 States and ratified by 93 States (as of June 1997.) It was signed by the U.S. on Jan 13, 1993 and ratified on April 25, 1997. Part XI of the Convention, "Investigations in Cases of Alleged Use of Chemical Weapons," details some of the procedures. [<http://www.unog.ch/frames/disarm/distreat/chemical.htm>]

The investigator searches the medical records to determine if personnel were injured as a result of the incident. Deaths, injuries, sicknesses, etc. near the time and location of an incident may be telling. Medical experts should provide information about alleged chemical casualties.

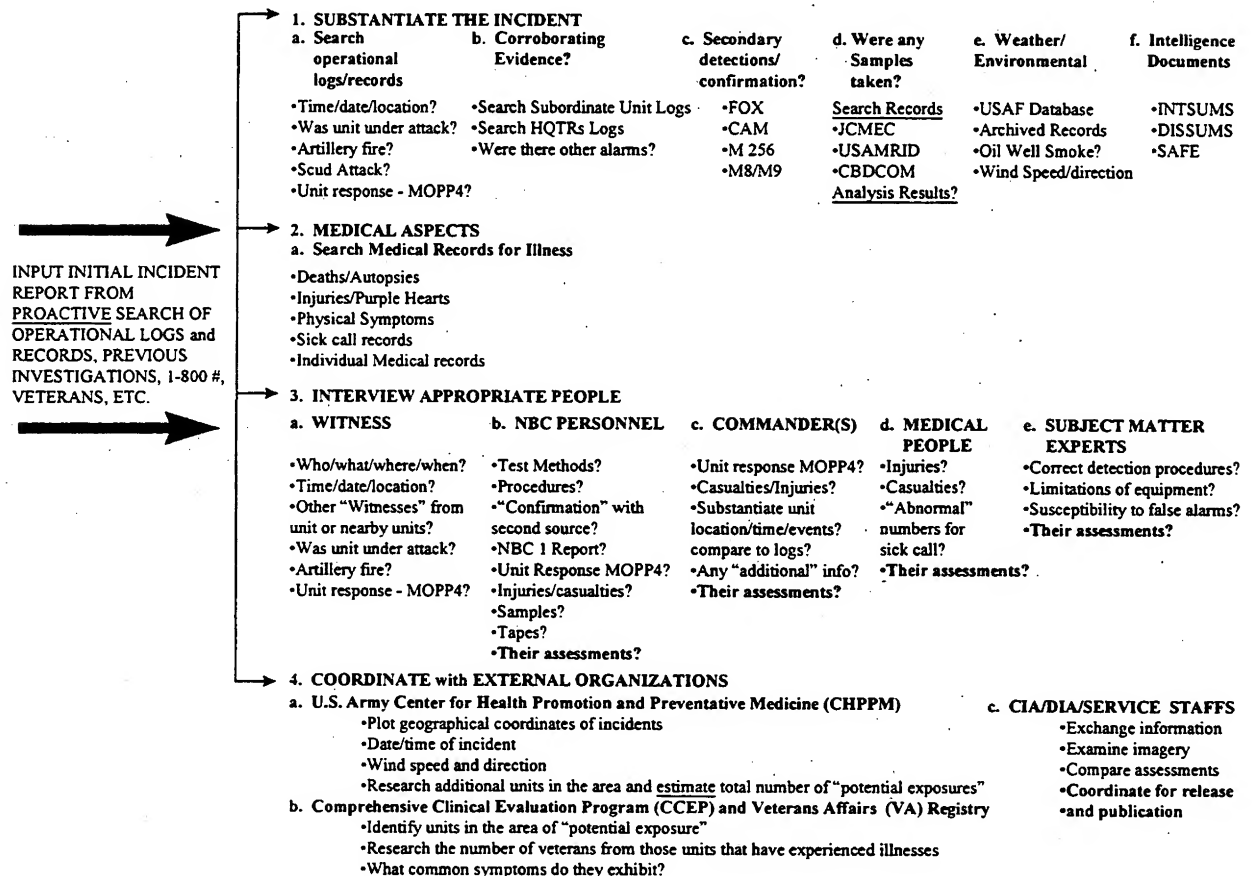


Figure 6. Chemical Incident Investigation Methodology

Interviews of incident victims (or direct observers) are conducted. First-hand witnesses provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved, and are particularly important if physical evidence is lacking. NBC officers or personnel trained in chemical and biological testing, confirmation, and reporting are interviewed to identify the unit's response, the tests that were run, the injuries sustained, and the reports submitted. Commanders are contacted to ascertain what they knew, what decisions they made concerning the events surrounding the incident, and their assessment of the incident. Where appropriate, subject matter experts also provide opinions on the capabilities, limitations, and operation of technical equipment, and submit their evaluations of selected topics of interest.

Additionally, the investigator contacts agencies and organizations that may be able to provide additional clarifying information about the case. These would include, but not be limited to:

- Intelligence agencies that might be able to provide insight into events leading to the event, imagery of the area of the incident, and assessments of factors affecting the case.
- The DOD and Veterans' clinical registries, which may provide data about the medical condition of personnel involved in the incident.



# Case Narrative

## Al Jubayl, Saudi Arabia

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on significant events that occurred in the greater Al Jubayl area. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events that occurred in Al Jubayl. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997224-0000-013

Last Update: August 13, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DOD) established a task force in June 1995 to investigate all possible causes. On November 12, 1996, responsibility for these investigations was assumed by the Investigation and Analysis Directorate (IAD), Office of the Special Assistant for Gulf War Illnesses (OSAGWI) which has continued to investigate the events that occurred at Al Jubayl, Saudi Arabia. Its interim report is contained here.

As part of the effort to inform the public about the progress of this effort, DOD is publishing on the Internet and elsewhere accounts related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling these accounts.

## METHODOLOGY

During and after the Gulf War, people reported that they had been exposed to chemical warfare agents. To investigate these incidents and to determine if chemical weapons were used, the DOD developed a methodology for investigation and validation based on work done by the United Nations and the international community where the criteria include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation or human/animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by experts.

While the DOD methodology (Tab D) for investigating chemical incidents is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, our methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

By following our methodology and accumulating anecdotal, documentary, and physical evidence, and by interviewing eyewitnesses and key personnel, and analyzing the results, the investigator can assess the validity of the presence of chemical warfare agents on the battlefield. Because information from various sources may be contradictory, we have developed an assessment scale (Figure 1) ranging from "Definitely" to "Definitely Not" with intermediate assessments of "Likely," "Unlikely," and "Indeterminate." This assessment is tentative, based on facts available as of the date of the report publication; each case is reassessed over time based on new information and feedback.

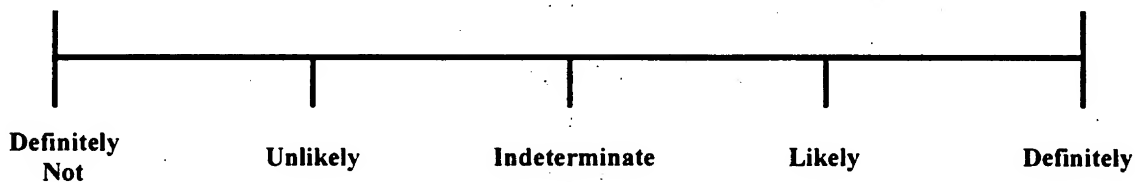


Figure 1. Assessment of Chemical Warfare Agent Presence

The standard for making the assessment is based on common sense: do the available facts lead a reasonable person to conclude that chemical warfare agents were or were not present? When insufficient information is available, the assessment is "Indeterminate" until more evidence can be found.

## EXECUTIVE SUMMARY

This Case Narrative provides information concerning significant events that occurred in and around the greater Al Jubayl<sup>1</sup> area during Operation Desert Shield/Desert Storm (ODS/DS). The narrative contains a discussion of each of the three significant events that occurred: "Loud Noise," "SCUD Impact," and "Purple T-Shirt." Included is a short history of the area and a discussion of the environment in which the units stationed in the Al Jubayl area existed.

### Loud Noise

The "loud noise" event occurred in the early morning hours (0332 local time) of January 19, 1991. A very loud noise was heard throughout the entire Al Jubayl area. General Quarters (GQ) was sounded and Mission Orientated Protective Posture (MOPP) level four was implemented throughout the area. The loud noise has been described as a single explosion, as two explosions, and as a sonic boom. Some people also reported seeing what appeared as a flash of light or fireball in the sky. As part of the response, NBC teams began testing for the presence of biological and chemical munitions. Although some locations reported an initial positive test for nerve agent and blister agent, all subsequent tests were negative.

Two coalition aircraft have been identified as the most likely source for the loud noise. Electronic data from Airborne Warning and Control System (AWACS) aircraft was analyzed by personnel of the 552d Computer Group located at Tinker AFB, OK. This data shows that two coalition aircraft were exceeding the speed of sound, causing a sonic boom as they flew over the city of Al Jubayl at approximately the same time the "loud noise" was heard and reported. A second incident of loud explosions was reported on January 20-21, 1991. As on the previous day, units in the Al Jubayl area sounded General Quarters and went to MOPP level 4. NBC teams checked for the presence of biological and chemical agents with negative results. However, these explosions were probably caused by a SCUD missile. The time of this event corresponds approximately to the time that a SCUD missile was launched towards Dhahran and was most likely intercepted by a Patriot air defense missile at very high altitude. Although there is no record of a reported impact site, this event is confirmed by numerous command log entries and the SCUD launch database. Based on the information that is available to date, our assessment is that the presence of a chemical or biological warfare agent in the Al Jubayl area during the time period in question (January 19-21, 1991) is judged to be "Unlikely."

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<sup>1</sup> Different spellings of Al Jubayl can be found in numerous documents both official and unofficial (for example--Al Jubayi, Al Jubail, or Jubail). For clarity, Al Jubayl will be used in this document.

## **SCUD Impact**

On February 16, 1991, the 66<sup>th</sup> SCUD missile launched during the war was against Al Jubayl. The missile was an Al Hussein variant of the SCUD missile. It impacted in the waters of Al Jubayl harbor and broke up at approximately 0200 hours on February 16, 1991. There was no damage or injury to coalition personnel or equipment. Eyewitnesses to the event report seeing an explosion that looked as if the SCUD was intercepted by a Patriot missile. There was a Patriot Missile Battery located near the harbor. However, during this time period, the battery was not operational and could not have engaged and shot down the SCUD missile. Salvage operations of the missile began on February 22, 1991. During the operation, EOD personnel used an M18 chemical detection kit to check for the presence of chemical warfare agents. The operation ended on the March 2<sup>nd</sup> with the recovery of the warhead. During the recovery and render safe operations, EOD members found no evidence of chemical or biological agents. Based on the information that is available to date, our assessment is that the SCUD was "Definitely Not" armed with a chemical or biological warfare agent.

## **Purple T-Shirt Event**

On March 19, 1991, seven personnel from Naval Mobile Construction Battalion 24 (NMCB-24) required medical attention after becoming exposed to unidentified airborne noxious fumes. These fumes resulted in acute symptoms, such as burning throats, eyes and noses, and difficulty in breathing. In addition, portions of their brown T-shirts turned purple. It was also reported that portions of some of these same individuals' combat boots also turned purple. The NMCB 24 personnel who were involved in the incident said they experienced a choking sensation when a "noxious" cloud enveloped them. None of those who were affected saw the origin of the gas cloud but all believed the cloud came from an industrial plant that was located near Camp 13. One individual, a Master Chief Equipment Operator (EQCM) (E-9) is the only eyewitness positively identifying the source of the noxious cloud as a fertilizer plant located near the camp. The majority of those who were exposed immediately sought medical attention and, after removal of contaminated clothing and showering, returned to work with no further symptoms.

Three analyses have been done to determine what could have caused the T-shirts to change color. The first study was supposedly conducted in Saudi Arabia shortly after the incident occurred; but no record of the analysis exists – only the recollections of NMCB-24 medical personnel. They claimed they bagged the T-shirts and turned them over to a group of Marines and Saudi officials. The second analysis was conducted by the U.S. Army Materiel Test Directorate, White Sands Missile Range, in July 1993. They tested a T-shirt with small holes on its front and back. The origin of the T-shirt is unknown but it

is not believed to be one of the T-shirts that turned purple. They could not definitely determine what caused these particular holes, but they surmised from a previous study that the holes were caused by some type of an acid. The third analysis was conducted by Natick Laboratories in May 1994. The report is quite specific, and states that ammonia (a suspected cause) would not change the color of the T-shirts. The color change could only occur in response to a strong oxidizer such as nitric or sulfuric oxides -- by products of industrial area operations. Although studies were conducted on T-shirts, no testing was done on combat boots. Based on the information that is available to date, our assessment is that the presence of a chemical or biological warfare agent at Camp 13 and the surrounding area on March 19, 1991 is judged to be "Definitely Not."

### **Environmental Factors & Other Related Topics**

The Purple T-shirt event illustrates the heavily industrialized environment of Al Jubayl. The heavy concentration of industries there meant personnel who lived and worked in Al Jubayl could possibly have been exposed to a variety of industrial chemicals. During interviews of personnel who were stationed in Al Jubayl, investigators asked for each person's impression of Al Jubayl's environment. As might be expected, investigators received both positive and negative comments. To provide as clear a picture as possible of Al Jubayl and the surrounding area, the last section of this case narrative is devoted to discussing Al Jubayl's environment.

During the pre-deployment phase of Operation Desert Shield/Desert Storm (ODS/DS), military planners became aware of the heavy concentration of industry in Al Jubayl. The large number of industrial complexes located within a relatively small geographic area was of special concern. Many of these facilities used, produced, or stored industrial chemicals that could pose a serious health risk to military personnel, if they were exposed. The large number of personnel and equipment that were scheduled to deploy and redeploy through Al Jubayl compounded the problem. Because of the concern, several studies were done to determine what hazards existed in Al Jubayl.

Despite Al Jubayl's heavy industrialization, studies have confirmed that the Saudi Arabian Government had stringent environmental standards in place long before the commencement of ODS/DS. The city of Al Jubayl, together with Yanbu, "are believed to be among the most environmentally clean of any comparable urban concentrations in the world."<sup>2</sup> It has been reported that the Saudi environmental standards parallel those of the U.S. Environmental Protection Agency (EPA).

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<sup>2</sup> Pamphlet, United Nations Environment Programme, Sasakawa Environment Prize, United Nations, Environment Programme. *1995 UNEP Sasakawa Environment Prize* (Nairobi, Kenya: United Nations, 1995) p. 16.

## NARRATIVE (An acronym listing/glossary is at Tab B)

### History Of Al Jubayl

Al Jubayl, Saudi Arabia is the largest of eight "planned" industrial cities, designed to take advantage of Saudi Arabia's vast oil resources. The city is located on the Persian Gulf coast, approximately 250 kilometers (km) south of the Saudi Arabian-Kuwaiti border (Figure 2).



Figure 2. Map of Saudi Arabia

The Al Jubayl area was developed as an industrial city in the early 1980s. Prior to that time, the landscape of what now comprises Al Jubayl was essentially an uninhabited and unused desert coastline.

Al Jubayl City consists of an industrial zone and port facilities (Figure 3). The city also contains a residential area and other non-commercial areas. The industrial zone of Al

Jubayl is a nine kilometer by nine kilometer area, located approximately five kilometers inland from the Persian Gulf coast. Jubayl Naval Air Facility (JNAF) lies northwest of the city and is approximately 20 km inland. King Abdul Aziz Naval Base (KAANB) is a Naval Station and airfield complex located on the coast, 20 km southeast of the city.

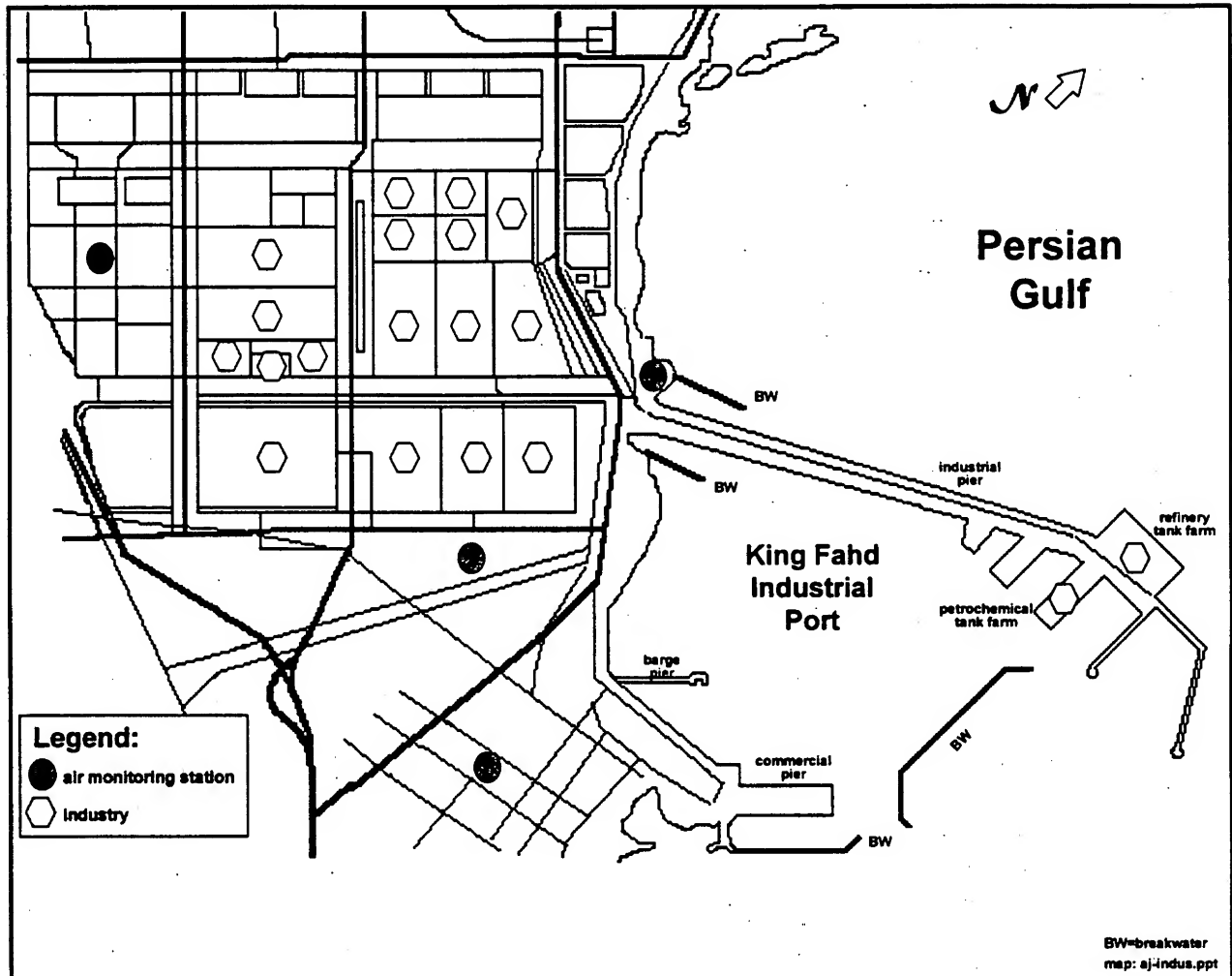


Figure 3. King Fahd Industrial Port and Jubayl Industrial City  
Al Jubayl, Saudi Arabia

Housing camps were located throughout the industrial zone to house the hired work force. Several of these camps were used as billeting and administrative spaces for U.S. forces deployed to Al Jubayl. Two Naval Mobile Construction Battalions (NMCB) NMCB-40 and NMCB-24 occupied one of these camps (Camp 13) throughout ODS/DS. Camp 13,

which was temporarily renamed Camp Rohrbach,<sup>3</sup> was located in the north central part of the industrial area (Figure 4). NMCB-40 and NMCB-24 were the first tenants of Camp 13. The camp was built some years before ODS/DS but never used. During the Gulf War, Camp 13 was a fenced, two-kilometers-square compound and was surrounded by various industrial plants, including a fertilizer plant, petrochemical plants, and a steel company. An adjacent area, located directly across the street from the main camp, was used as the motor pool. Units of other coalition forces were located near Camp 13. One such unit was British -- probably the British 1st (UK) Armored Division, 7<sup>th</sup> Armored Brigade "Desert Rats." And, there may also have been a Saudi Arabian military unit located in the area of Camp 13.

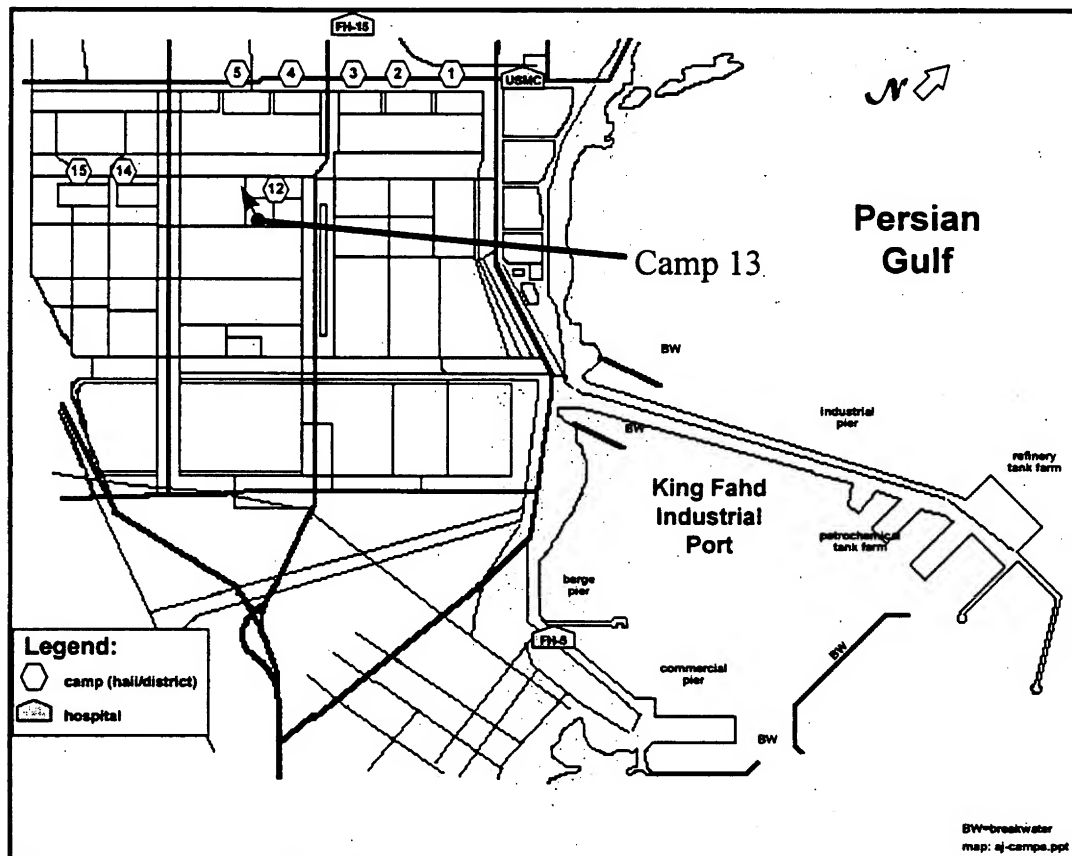


Figure 4. Location of Housing Camps and Military Hospitals in Al Jubayl

<sup>3</sup> Camp 13 was informally renamed Camp Rohrbach in honor of the late Rear Admiral Richard M. Rohrbach. During his military career, Admiral Rohrbach distinguished himself in performing a variety of command and leadership positions within the Seabees. Source: Transcript of Naval Service for Rear Admiral (Lower Half) Richard M. Rohrbach, Civil Engineering Corps, U. S. Navy, August 1, 1990.



Al Jubayl played a crucial role during ODS/DS. Almost all Marine Corps personnel deployed through the port city, as well as many Army units. The Navy positioned several Fleet hospitals in the area and the Air Force had units on the ground to support airlift missions and medical evacuation missions. The following section describes two units that are crucial to the significant events reported in this case narrative.

### **Units Involved**

During ODS/DS, Al Jubayl was occupied primarily by U.S. Navy and Marine Corps units (see Tab C). The U.S. Marine Corps First Marine Expeditionary Force (IMEF) and 3<sup>rd</sup> Marine Air Wing were located in Al Jubayl during ODS/DS. Other units, such as the Army's 702<sup>nd</sup> Transportation Battalion and a Patriot Missile Battery were also located in Al Jubayl. Units were located in the immediate harbor area, at local airfields, and in the industrial areas throughout the city (such as Camps 5, 13 and 15). Although many units were positioned in Al Jubayl before the ground war, most combat and combat support units deployed northward during the ground war. Two units, NMCB-24 and the Coast Guard's Port Security Unit (PSU)-301, are the focus of this narrative because they are central to the major events that occurred at Al Jubayl.

Documentation from other units located in the Al Jubayl area was also reviewed. Interviews of personnel assigned to these units were conducted to develop additional information. A listing of units that passed through or remained in Al Jubayl is available for review. These lists are not complete and do not cover the entire Gulf War deployment period, but will be updated as information becomes available.

### ***Naval Mobile Construction Battalion (NMCB)-24***

NMCB-24, a reserve unit headquartered in Huntsville, AL, was activated in November 1990. NMCB-24 arrived in Saudi Arabia in December 1990 and reported to the 3<sup>rd</sup> Naval Construction Regiment. NMCB-24's mission was to support IMEF and other coalition force engineering and construction requirements. NMCB-24 was stationed at Camp 13 with NMCB-40, an active duty Seabee unit that arrived at Camp 13 in September 1990. The Commanding Officer of NMCB-40 was also the Commandant of Camp 13. NMCB-24 was divided into five companies: Headquarters, Alpha, Bravo, Charlie, and Delta. The Headquarters, Alpha, Bravo, and Charlie Companies were stationed at Camp 13. Delta Company (referred to as the "Air Det") was located 20 kilometers away at KAANB. In addition to personnel normally assigned as reservists, NMCB-24 was augmented with approximately 100 personnel from other U.S.-based reserve Seabee units. NMCB-24's assigned personnel strength totaled 724 enlisted personnel and 24 officers.

NMCB-24 conducted construction operations in and around Al Jubayl, and deployed forces to Al Khanjar (referred to as Camp Smith or Lonesome Dove) and Al Jabar airfield in Kuwait. NMCB-24 returned to the U.S. on April 26, 1991.

### ***U.S. Coast Guard Port Security Unit (PSU) 301***

PSU 301 was an activated U.S. Coast Guard (USCG) Reserve unit and was manned by personnel coming from various USCG Reserve units throughout the U.S. PSU 301 was manned in two deployment phases, referred to as PSU 301-A and 301-B. PSU 301-A was relieved by 301-B in early March 1991. The PSU was attached to the Port Security and Harbor Defense (PSHD) Command, Group Two. Its primary mission was to conduct harbor patrol and surveillance. The PSU was responsible for interception, search, and apprehension of all suspicious or unidentified water craft in the areas of the port and harbor. PSU 301 was stationed at the port area of Al Jubayl and performed port security operations using "raider" gunboats.

A third unit that had an important role in Al Jubayl was the U.S. Navy's Explosive Ordnance Disposal (EOD) Team Detachment 33. Members of Detachment 33 recovered components of a SCUD missile after it impacted into the waters of Al Jubayl harbor and sank.

### **Explanation Of The Events That Occurred At Al Jubayl**

Members of NMCB-24 testified before the U.S. Senate's Banking, Housing, and Urban Affairs Committee (known as the Riegle Committee). Their testimony underscored the need to fully explain the unexplained or under-explained events which did occur at Al Jubayl. Our investigation has identified three separate events that are discussed in the following section.

#### ***Loud Noise***

Early reports tended to associate the "loud noise" event<sup>4</sup> with a second incident commonly referred to as the "purple T-shirt" event. But investigators have determined that these two events are unrelated and occurred approximately two months apart.<sup>5</sup> The

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<sup>4</sup> The term "sonic boom" is used in the description of events by eyewitnesses to this event. The command staff of NMCB-24 informed the troops that a sonic boom had occurred. This information is mentioned in the U.S. Senate Committee on Banking, Housing and Urban Affairs report dated May 25, 1994, referred to as the Riegle Report, pages 60-67.

<sup>5</sup> Investigation team personnel visited the Headquarters, NMCB-24 in Huntsville, Alabama on March 20-22, 1996, to review and obtain command and air detachment operational records and medical records.

"loud noise" event occurred during the period of January 19-21, 1991, and the "purple T-shirt" event occurred on March 19, 1991. Consequently, the "purple T-shirt" event is discussed separately in this report.

The investigation has also revealed that the events referred to as the "loud noise" of January 19-21, 1991, were actually two separate events—the first, occurring in the early morning hours of January 19, 1991, and the second during the late evening-early morning of January 20-21, 1991. The events of January 19 and 20-21, 1991 involved air-raid sirens, loud noises, and unit alerts. The M-8 chemical detectors issued to NMCB-24 did not detect any chemical agents at Camp 13 during January 19-21, 1991, or at any time during ODS/DS.<sup>6</sup>

Sixty-seven NMCB-24 personnel were interviewed, including the command staff, NBC team members, medical personnel, and unit personnel. Seven of these individuals also testified before Congress. Their recollections differed. Some recalled a mist in the air, which would have indicated the presence of a significant concentration of an airborne substance,<sup>7</sup> while others recalled a wind blowing and no mist.<sup>8</sup> Some recalled immediate symptoms (burning eyes and skin) while others did not experience any symptoms. The symptoms that were described are not consistent with symptoms associated with exposure to chemical warfare agents.

### **January 19, 1991 Chronology**

At approximately 0332 hours local time on January 19, 1991, a very loud noise was heard at Camp 13 and in the entire Al Jubayl area. General Quarters (GQ) was sounded.<sup>9</sup> At 0325 hours, Security Post 5 reported that two blasts had occurred west of Camp 13. A second security post reported that a white cloud was moving towards Camp 13 from the south.<sup>10</sup> At 0407 hours, the NMCB-24 NBC Warfare officer had an NBC team member check for the presence of chemical/biological agents at Camp 13 using a M-256A1 detection kit (see glossary). The results of these tests were negative.<sup>11</sup> A second check

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<sup>6</sup> Interviews of NMCB-24 Nuclear, Biological and Chemical (NBC) reaction team members are conflicting relating to the use of M-8 detectors. The NBC officer stated that the alarms did not go off but that they were working properly (Lead Sheets 1104 and 1009). Another NBC team member stated that the M-8 detectors were not in operation (Lead Sheet 1097).

<sup>7</sup> Interview notes (Lead Sheets 1151, 1099, 1176, 1180, 1161, 1178, 632, 55 and 983).

<sup>8</sup> Lead Sheets 1097, 1104, 1009, op.cit.; Ibid., Lead Sheet 983.

<sup>9</sup> Excerpts of Command Post Log, Naval Mobile Construction Battalion-24, entry of 0332 (Local) 19-21 January 1991 and 19 March 1991, and Watch Log Extract, 3<sup>rd</sup> Battalion 24<sup>th</sup> Marines Watch Log.

<sup>10</sup> Security Log, Naval Mobile Construction Battalion-24, entries at 0325, 0326, 0327, 0338, 0345, and 0545 on 19 January 1991.

<sup>11</sup> NMCB-24 Command Post Log, op.cit.

using the M256A1 kit was conducted at 0459 hours (local).<sup>12</sup> This test was also negative for chemical agents. At 0501 hours (local), a log entry notes that a test for chemical agents in the port area was conducted with negative results.<sup>13</sup> At 0541, Camp 13 returned to MOPP level 0+ and secured from General Quarters at 0545 hours.<sup>14</sup> The NMCB-24 "Air Det" log at KAANB contains entries denoting a sonic boom at 0330 hours, an air raid at 0400 hours, and at 0500 hours the detachment was secured from the air raid. There is no record of any chemical detection tests being run by NMCB-24 Air Detachment personnel.<sup>15</sup>

However, a member of NMCB-24's Air Detachment reported during congressional testimony and in interviews conducted by investigators that he conducted several M256A1 tests which were positive for mustard/blister agent two out of three times. He also claimed that one individual, a member of the Air Detachment, developed a blister on his wrist under his wristwatch.<sup>16</sup> These detections were not recorded in either the NMCB-24 Command log or "Air Det" logs, nor are there any records of such an event being reported to higher headquarters. This individual testified that he informed the air detachment leaders of the positive results of his M256A1 tests. An officer who was the assistant Officer in Charge (OIC) of the Air Detachment stated he was in a position to receive such a report and was never informed of these positive tests.<sup>17</sup> In an interview with investigators, the NMCB-24 Air Detachment OIC stated that the person who reported the positive tests had been detailed by the Air Detachment to the Marine Chemical Biological Radiological (CBR) element at KAANB. The Air Det OIC stated that during attack alerts, this individual was under the control and direction of the Marine's Defense Operations. The Air Det OIC emphasized that he and his personnel (the Air Detachment) were under the control of the KAANB Commander who was a Marine Colonel. Any CBR monitoring, surveying, reporting, or decontamination operations took place under the direction and control of the KAANB Commander. He further stated that the Marines (MAG-13) ran a "tight ship" and were very sensitive to the timely flow of information up and down the chain of command. The Air Det OIC does not remember anyone reporting to him that blister agent had been detected. He stated that he "would have remembered such a report. The talk about a chemical detection during the early morning hours was exactly that, talk." He stated that he and all the rest of the tenant unit commanders were "out and about" during the loud noise event and that there were no reports from any unit or the MAG-13 CBR team that any agent had been detected or that there were any injuries suffered or treated.<sup>18</sup> No one in the Air Det was a

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<sup>12</sup> NMCB-24 Command Post Log, op.cit.

<sup>13</sup> NMCB-24 Command Post Log, op.cit.

<sup>14</sup> NMCB-24 Command Post Log, op.cit.

<sup>15</sup> NMCB-24 Air Detachment Log for January 19-21, 1991; Lead Sheet 977, op.cit.

<sup>16</sup> Riegle Report, op.cit., page 66

<sup>17</sup> Quotation taken from newspaper article by Phil Shenon, New York Times, 20 December 1996.

<sup>18</sup> Interview notes (Lead Sheets 5290).

sick bay casualty during or after the 19<sup>th</sup> of January as a result of the attack alert. During an interview, a Hospital Corpsman Senior Chief (HMCS), who was the senior medical corpsman for NMCB-40 and Camp 13, stated that he does not remember the individual from the Air Detachment who developed a blister, but added that he treated a lot of similar cases at Camp 13. He said the blister was most likely caused by ringworm or other fungus that grew under a person's wristwatch. He explained that if a watch was worn too tightly, heat and humidity built up under the watch, allowing the fungus to grow.<sup>19</sup>

During this time period, a Central Command (CENTCOM) NBC log entry at 0430 hours noted that there was an earlier report of a chemical attack at Al Jubayl. A British unit (not identified in the log) had a "slight" Chemical Agent Monitor (CAM) reading for mustard. British NBC control sent an NBC team to the site of the reading to conduct further tests. They did not receive a positive indication for a chemical agent and reported "All Clear" to CENTCOM NBC. At 0440 hours, the British reported that another one of their units was getting a positive reading for mustard using M9 detection paper (see glossary) and that a propeller driven aircraft was heard in the area. At 0510 hours, CENTCOM NBC contacted the British NBC team that was sent out to verify the earlier report and found they were at MOPP 0 and did not have any positive M9 paper readings. Because of the conflicting reports, CENTCOM NBC teams were dispatched at 0518 hours to the sites where the British detections occurred (near Camp 5 in the industrial zone) to recheck the area. At 0615 hours, a CENTCOM NBC team lead by a Chief Warrant Officer Three (CWO3) performed a reconnaissance of the area between the two British detections. At 0748 hours, log entries report that no positive readings were taken and that two separate sweeps found no chemicals or debris in the area. This entry does make note of a large diesel fuel spill in the middle of the suspect area.<sup>20</sup>

Eyewitnesses at Camp 13 describe a large fireball that illuminated the sky, a concussion wave, and a mist in the air.<sup>21</sup> Interview quotes include: "I remember getting woke up by this huge explosion -- it almost knocked us out of our bunks."<sup>22</sup> "I am a Viet Nam War Vet, and my thoughts were that it was a rocket."<sup>23</sup> "I initially thought it was incoming artillery rounds."<sup>24</sup> Several personnel experienced acute symptoms such as runny noses, numbness and burning sensations on their lips, eyes, and skin following this explosion. "Right after I got into the bunker, my lips started turning numb and the numbness lasted for several days." "Nobody believed it was a sonic boom -- nobody. I've been in the

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<sup>19</sup> Interview notes (Lead Sheets 3872).

<sup>20</sup> Nuclear Biological Chemical (NBC) Desk Log, US Central Command (USCENTCOM), January 19, 1991.

<sup>21</sup> Lead Sheets 1180 and 1178, op.cit.

<sup>22</sup> Interview notes (Lead Sheet 1173).

<sup>23</sup> Phil Shenon, op.cit.

<sup>24</sup> Interview notes (Lead Sheet 1227).

military most of my life and I know that a sonic boom doesn't leave a flash of red light in the damn sky." "We washed down and that seemed to help, but people started coming up with blisters."<sup>25</sup> Eyewitnesses also stated that those experiencing symptoms reported for medical attention within the next few days. Investigators interviewed the NMCB-24 commander, medical personnel, and senior non-commissioned officers assigned to Camp 13 and reviewed the unit's sick-call logs. Investigators found no record indicating that any individual sought medical attention on January 19<sup>th</sup> or the following few days for the types of symptoms that were reported.<sup>26</sup>

Several eyewitnesses, who were located at Camp 13, stated that they smelled an ammonia-like odor, while others do not recall any significant odor or smell. NMCB-24 (for Camp 13) logs do not mention the presence of any odor during the time of the loud noise. Some personnel have stated that they were unprotected during that time and exhibited no symptoms that would have indicated exposure to a chemical agent. A Builder 2<sup>nd</sup> Class assigned to NMCB-24 stated that during the alert he volunteered to leave the bunker, located at Camp 13, to conduct a M256A1 chemical test. Once outside, he became aware that he had forgotten his MOPP gloves in the bunker. He elected not to return to the bunker for his gloves and continued to test for the presence of chemical agents. He stated that he did not develop any symptom related to an exposure to a chemical agent.<sup>27</sup>

Records of other units stationed in Al Jubayl describe a series of loud explosions occurring on January 19, 1991. For example, the NMCB-24 Air Detachment Log contains an entry reporting the sonic boom at 0330 hours.<sup>28</sup> The command history of Critical Facility Force (CFF) describes the British positive blister agent reading.<sup>29</sup> The IMEF journals also contain entries that discuss the British detections.<sup>30</sup> The Logistics Operations Center's daily update states that the reported mustard gas attack at Al Jubayl was actually an ammonia plant setting off alarms and that the booms were from aircraft.<sup>31</sup> The KAANB Commander (a Marine aviator) has also stated the loud noise was caused by two aircraft. He said it was the loudest sonic boom he had ever heard. He said that he immediately called the command center and was told by the duty watch that the Marine Tactical Air Control Center (TACC) had informed them that the source of the loud noise

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<sup>25</sup> Phil Shenon, op.cit.

<sup>26</sup> Naval Mobile Construction Battalion-24, Medical Admin Log, January 20-22, 1991; NMCB 24 (Camp 13) Sick Call Log-January 19-20, 1991; NMCB 24 (Air Detachment) Sick Call Log, January 19-23, 1991.

<sup>27</sup> Lead Sheet 1097, op.cit.

<sup>28</sup> Air Detachment Log, op.cit.

<sup>29</sup> General Support Group 1, 1st Force Service Support Group, Deputy Commander, Critical Facility Force (CTF), Command Chronology for January 1991.

<sup>30</sup> First Marine Expeditionary Force (IMEF), G-3 journals dated January 19, 1991, at 0407, 0425, and 0525.

<sup>31</sup> Daily Update from Logistics Operations Center, dated 190800 Jan 1991.

was two Tornados heading towards the north.<sup>32</sup> Finally, what is believed to be a radio station log from an unknown Marine unit gives some insight into the level of confusion that existed in Al Jubayl from the loud noise and initial reports of positive test results for chemical agents.<sup>33</sup>

### **January 20-21, 1991 Chronology**

Late in the evening of January 20<sup>th</sup> (between 2140-2150 hours), a SCUD alert was issued and air raid sirens sounded throughout Al Jubayl. As a result, units in the area went to MOPP 4. At 2230 hours, units secured from General Quarters and went to MOPP 0. At 0046 hours on January 21, 1991, the air raid sirens were activated once again.<sup>34</sup> NMCB-24 security logs note two explosions occurring at 15-20 second intervals southeast of Camp 13 at 0054 hours. At 0115, units secured from the alert. NMCB-24 security logs also note that Saudi sirens sounded at 0142 hours.<sup>35</sup> The NMCB-24 "Air Det" log notes SCUD alerts occurring at 2200 hours on January 20<sup>th</sup>, and also at 0330 hours and 0445 hours on January 21, 1991. Approximately twenty minutes after each alert, the "All Clear" was given.

CENTCOM NBC logs for January 20-21, 1991 note that at 2147 hours two SCUD missiles were fired towards Jubayl-Dhahran and four Patriot missiles were fired -- destroying the SCUDs in the air. Additionally, CENTCOM logs contain no entries to indicate the presence of chemical or biological agents in the Al Jubayl area during January 20-21, 1991. At 2200 local, a third SCUD was fired and was also destroyed in the air.<sup>36</sup>

### *Findings of the Loud Noise Event (January 19, 1991)*

Thus far we have discussed information obtained from unit logs and personal interviews. Certainly there can be no doubt that a loud noise was heard during the early morning hours of January 19, 1991. What is debated, however, is the source of the loud noise. Many people who were interviewed believe the loud noise was caused by an incoming SCUD missile. Others believe the loud noise was caused by aircraft.

Based upon the information that has been reviewed to date, investigators have determined the loud noise was a sonic boom caused by coalition aircraft. Records reviewed to date show that no SCUDs were launched towards the vicinity of Al Jubayl on January 19,

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<sup>32</sup> Interview notes (Lead Sheet 5187).

<sup>33</sup> Radio Station Log from 24<sup>th</sup> Marines, 18-19 January 1991.

<sup>34</sup> NMCB-24 Command Post Log, op.cit.

<sup>35</sup> NMCB-24 Security Logs, op.cit.

<sup>36</sup> Nuclear Biological Chemical (NBC) Desk Log, US Central Command (USCENTCOM), January 20-21, 1991.

1991.<sup>37</sup> However, as this was the third day of the air war, the skies were full of aircraft either flying to their assigned targets or on their way back to their home station. Many aircraft had to be refueled while airborne in order to complete their mission. To maintain a steady flow of aircraft and fuel, as well as prevent a mid-air disaster, refueling aircraft (both tankers and the aircraft to be refueled) were required to fly assigned routes or orbits. The sheer size of the air campaign required many refueling routes over Saudi Arabia, including over the port city of Al Jubayl.

To identify aircraft as the source for the loud noise, investigators reviewed the Air Force Central Command (CENTAF) Air Tasking Order (ATO) for the air campaign. The ATO shows that several sorties were scheduled during the early morning hours of January 19, 1991, which would have overflowed Al Jubayl.<sup>38</sup> To further isolate and identify the aircraft most likely to have caused the sonic boom, data recorded by Airborne Warning and Control System (AWACS) aircraft was analyzed by the Department of the Air Force's 552d Computer Group (ACC) located at Tinker AFB, Oklahoma.<sup>39</sup> This data shows that two coalition aircraft (aircraft "A" and "B" shown in Figure 5) were exceeding the speed of sound<sup>40</sup> as they flew over Al Jubayl at approximately the same time the "loud noise" was heard and reported (approximately 0332 hours local time). Aircraft "A" flew the closest to Camp 13 and was accelerating through 638 knots (733.7 mph) to 652 knots (749.8 mph) while flying over the city at 0327 hours plus nine seconds local time. Aircraft "A" continued to accelerate out over the gulf achieving a top speed of 924 knots (1062 mph) at 0333 hours local time. Aircraft "B" flew a course that led it over the outskirts, south of Al Jubayl. Aircraft "B" approached Al Jubayl at 0327 hours and 16 seconds local time at a speed of 700 knots (805 mph). Aircraft "B" accelerated as it passed by the city and achieved a top speed of 873 knots (1003.95 mph) at 0327 hours and 57 seconds local time.

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<sup>37</sup> Report, (S/NF), HQ USPACECOM, United States Space Command Operations Desert Shield and Desert Storm Assessment (U), January 92, pp 74-76.

<sup>38</sup> (S), CENTAF Operation Desert Storm and Desert Shield Air Tasking Order. (U)

<sup>39</sup> Letter w/attachment, Department of the Air Force 552d Computer Group (ACC) Tinker AFB, Oklahoma, Request for Assistance, not dated.

<sup>40</sup> The speed of sound is approximately 750 miles per hour at sea level. Source: U. S. Air Force FACT SHEET 96-03.



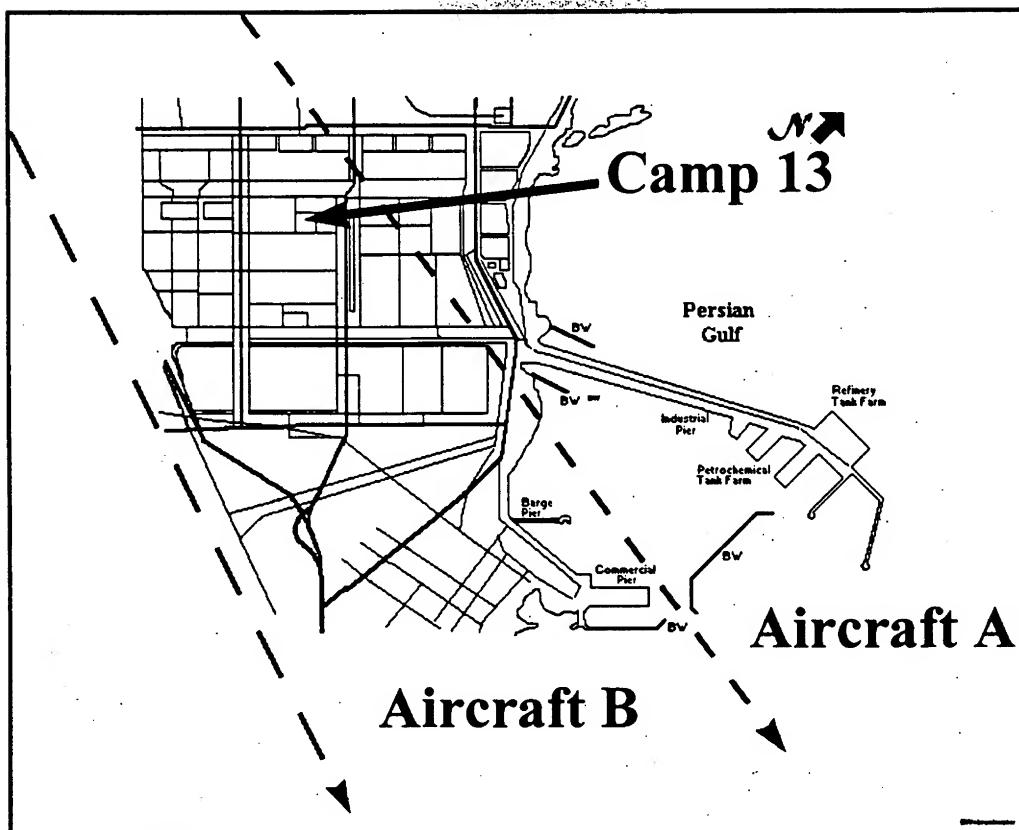


Figure 5. Flight Paths of Aircraft Suspected of Causing the "Sonic Boom"

*Assessment of the Loud Noise Event (January 19, 1991)*

Based on the information that is available to date, the presence of a chemical or biological warfare agent in the Al Jubayl area during the Loud Noise Event is judged to be "Unlikely." This assessment is based upon the following information:

- knowledge that there were no SCUD missiles launched in the direction of Saudi Arabia on January 19, 1991.
- there were no verifiable tests conducted in the Al Jubayl area that tested positive for chemical warfare agents.
- no records have been found of any individual receiving medical treatment of symptoms associated with exposure to chemical or biological warfare agents.

### *Findings of Events That Occurred on January 20-21, 1991*

The January 20-21, 1991, incident involved air raid sirens and a reference to "two explosions southeast of camp." Available records indicate that chemical detection tests were negative. The time of this event corresponds approximately to the time that a SCUD missile was launched towards Dhahran and was most likely intercepted by a Patriot air defense missile at very high altitude. Although there is no record of a reported impact site, this event is confirmed by numerous command log entries and the SCUD launch database.

### *Assessment of Events That Occurred on January 20-21, 1991*

Based on the information that is available to date, the presence of a chemical or biological warfare agent in the Al Jubayl area during the events of January 20-21, 1991 is judged to be "Unlikely." This assessment is based upon the following information:

- that events recorded in numerous command log entries and the SCUD launch database show that a SCUD missile was launched and intercepted at approximately the same time as the events recorded in logs of units located in Al Jubayl.
- that there is no record of an impact site in the Al Jubayl area.
- no records have been found of any individual receiving medical treatment of symptoms associated with exposure to chemical or biological warfare agents.

Through the early stages of the war, Al Jubayl was spared from direct missile attack. This did not keep units within the Al Jubayl area from having to respond to air raid warnings and increase the MOPP level each and every time a SCUD alert was issued. SCUD missiles that could be seen from Al Jubayl were those flying over the city -- apparently targeted against Dhahran or other targets located south of the city. This all changed on February 16, 1991, when a SCUD impacted in Al Jubayl harbor.

### ***SCUD Impact***

During the Gulf War, the Iraqis fired a total of 88 SCUD missiles. A brief discussion of SCUD history and characteristics is contained at Tab D. The attack against Al Jubayl occurred a little over a month into the war and was the 66th missile the Iraqis launched.<sup>41</sup>

The Iraqis launched the 66<sup>th</sup> missile at approximately 0200 hours local on February 16, 1991. U.S. National sensors detected the missile early in flight and provided prompt

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<sup>41</sup> Case Study, Secret, Center for Naval Analyses (CNA), Case Study of a Tactical Ballistic Missile (TBM) Attack: Al Jubayl, Saudi Arabia, 15-16 February 1991 (U), August 1996, page 1.

warning of the launch. The incoming missile was the Al Hussein variant of the SCUD. It impacted in the harbor, approximately 150 meters from the commercial pier where an ammunition storage area was located and approximately 1000 meters from the *USS Tarawa*. Other ships that were in the harbor at the time of the SCUD impact included the *USS Button*, the *USS Cleveland*, and a Merchant Marine vessel--the *Santa Adele*.<sup>42</sup> The missile's warhead did not explode and it caused no damage. The U.S. Navy's Explosive Ordnance Disposal (EOD) Detachment 33 recovered most of the missile, including the warhead, from the harbor floor.

A Patriot missile battery was defending Al Jubayl. Although it received the launch warning, the Patriot battery was not-operational for maintenance reasons and was not able to engage the incoming missile.

According to excerpts from the U.S. Navy's EOD Detachment 33 log, air raid sirens sounded in the city; the Harbor Defense Command (HDC) went to condition "Red", and the Rear Area Operations Center (RAOC) went to condition "Yellow."<sup>43</sup> The PSU 301 Command Duty Officer (CDO) heard an explosion outside of the command tent -- "something in the air and to the west." He recalls seeing "white hot luminescent objects still in the air." He then alerted the unit to General Quarters and contacted Harbor Defense Command.<sup>44</sup> Standard Operating Procedures required 3 Raider boats underway at all times. When General Quarters was sounded, PSU 301's three remaining Raiders got underway.<sup>45</sup> Other eyewitness accounts from PSU 301 personnel indicate that there may have been an airborne explosion; some accounts indicate two explosions.

PSU 301 and EOD boat crews responded rapidly to the SCUD impact. By 0230 hours, an EOD boat and a PSU 301 Raider had arrived at the scene of the SCUD impact. However, due to smoke and the strong smell of what was thought to be missile fuel,<sup>46</sup> the accompanying PSU 301 boat backed off. The EOD team surveyed the harbor's surface near the reported impact and located an area of major bubble activity and a strong smell of fumes. Approximately twenty minutes later, the EOD team marked the area with a surface buoy and returned to base.

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<sup>42</sup> CNA Study, op.cit., page 11.

<sup>43</sup> CNA Study, op.cit., page 18

<sup>44</sup> Interview notes (Lead Sheet 1410).

<sup>45</sup> Interview notes (Lead Sheet 1280).

<sup>46</sup> Although assumed to be missile fuel, the actual content of the fumes has not been identified. It is believed that SCUD missiles fuel was a mixture of Inhibited Red Fuming Nitric Acid and Hydrazine. These substances are highly toxic. Exposure to even small amounts of either substance can cause severe life threatening injuries. To date, no record of any individual has been found that indicates any of the personnel who responded to the impact or recovered the SCUD from the harbor has sought medical attention for injuries associated with exposure to either of these substances. Source: Howard Hughes Medical Institute Nitric Acid Fact Sheet and Hydrazine Fact Sheet.

At 0720 hours on February 16, 1991, the EOD team returned to the site in order to check the status of the marked area. Bubbles were still rising to the surface and the same smell of missile fuel remained in the area. At approximately 0930 hours an EOD boat equipped with an Underwater Damage Assessment Television System (UDATS) conducted a survey of the harbor bottom. After lowering the UDATS and surveying the area around the buoy, the team located missile debris, including an item which resembled a warhead. At 1450 hours, the EOD team conducted its first dive at the impact site. The divers confirmed the location of an intact SCUD warhead, along with the guidance section, rocket motor, and miscellaneous components. All major components were separated from each other, confirming that the missile had broken apart.<sup>47</sup>

### **The Recovery Operation**

In preparation for recovery operations, EOD personnel spent February 17<sup>th</sup> in consultation with their technical information center at Indian Head, MD. EOD personnel also made the requisite notifications to their command in Bahrain as well as other command entities located in the immediate port area. As expected, they also spent time responding to numerous requests for more detailed information.

On February 18<sup>th</sup>, the detachment's divers continued their survey of the harbor floor, and mapped the site using the UDATS. At 1500 hours, the Operational Commander of the Harbor Defense Command visited the EOD camp and received an update on the situation.

During the period February 19 -21, the EOD team conducted extensive searches of the harbor bottom and recovered smaller SCUD components with the aid of an underwater camera system. Divers also located and marked a fuel tank for retrieval.

The EOD team began salvage operations on February 22, 1991, at 0800 hours. Using lifting balloons, they retrieved three major non-explosive components: the fuel tank (Figure 6), the guidance section, and the rocket motor (Figure 7). The missile pieces were hoisted out of the water using a crane. While the components were suspended, they were sprayed with a fire hose to flush out sea water and any caustic substances that could have remained. The EOD crew flushed out the pieces for a second time once they were on the pier. Later, the components were taken to the EOD base camp for temporary storage.

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<sup>47</sup> CNA Study, op.cit., page 18.

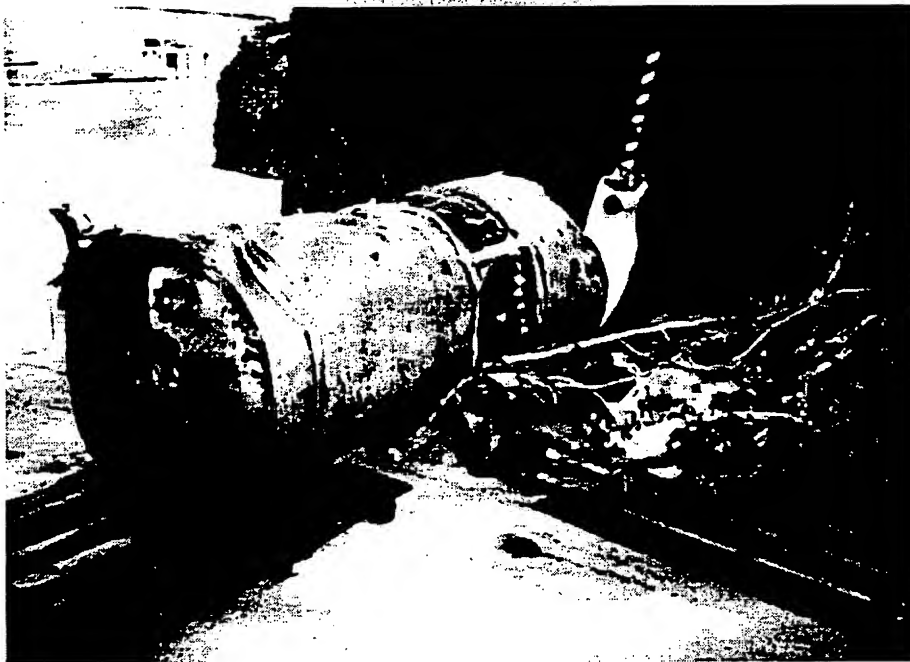


Figure 6. The Recovered SCUD's Fuel Tank

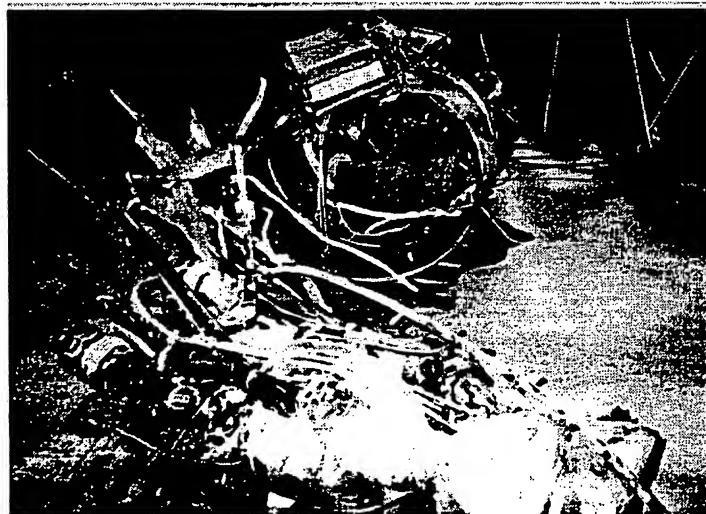


Figure 7. The Recovered SCUD's Guidance Section & Rocket Motor  
(rocket motor is in the foreground)

After the EOD team finished examining the recovered SCUD components, custody was transferred to the Joint Captured Material Exploitation Center (JCMEC) on February 23, 1991. JCMEC was a coalition entity responsible for collecting captured foreign military equipment throughout the Kuwait Theater of Operations (KTO).

Recovery of the warhead began on March 2, 1991, at 0600 hours. During an interview it was reported that EOD divers collected sediment samples from the area near the warhead prior to its recovery from the harbor.<sup>48</sup> However, investigators found no record that confirms soil samples were taken. By 1320 hours the warhead had been safely removed from the water and operations to render it harmless had begun. During the operation, EOD personnel used an M18 chemical detection kit to check for the presence of chemical warfare agents. The operation ended at 1715 hours. During the entire recovery operation, EOD members found no evidence of chemical or biological agents.

On March 3<sup>rd</sup>, the disarmed warhead was loaded onto a barge for shipment back to the EOD base camp in Al Jubayl (Figure 8). JCMEC personnel took custody of the warhead on March 8, 1991. JCMEC shipped the missile components to the Army Missile Command in Huntsville, AL.

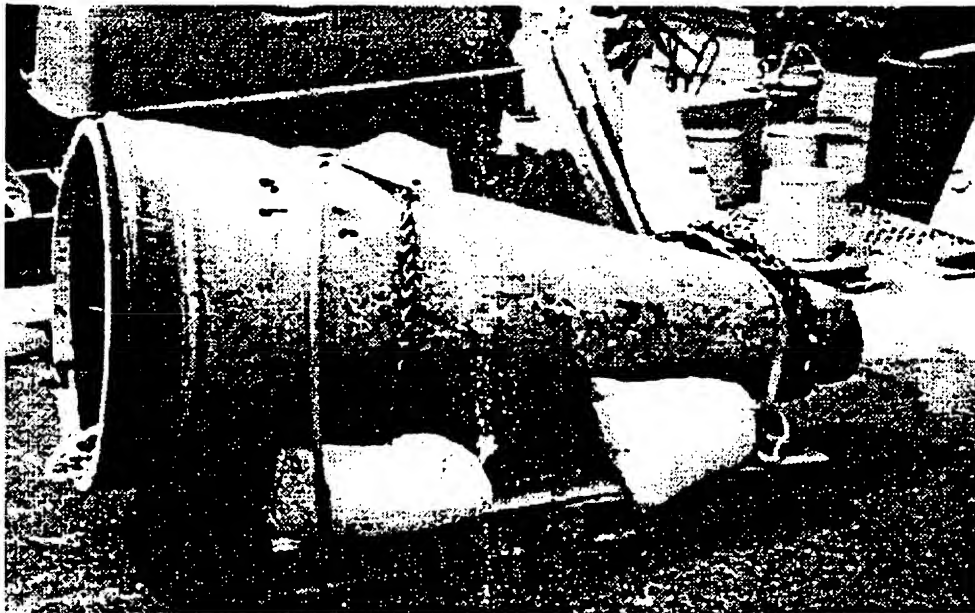


Figure 8. The Recovered SCUD's Warhead

#### *Findings of the SCUD Impact Event*

A SCUD missile did impact in the waters of Al Jubayl harbor on February 16, 1991. Eyewitnesses have reported the missile was intercepted and shot down by a Patriot missile. However, the Patriot battery that was located at Al Jubayl was not operational at the time and could not have shot down the SCUD. The SCUD did not detonate upon

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<sup>48</sup> Interview notes (Lead Sheet 1257).

impact with the water. There were no injuries to personnel or damage to equipment as the result of this incident. The missile was subsequently recovered from the harbor floor by Navy EOD personnel. Testing conducted at the time of recovery for chemical warfare agents were negative.

### *Assessment of the SCUD Impact Event*

Initially, as could be expected, this event received a considerable amount of attention. The opportunity to recover a SCUD nearly intact was not an everyday occurrence. The initial surge of interest diminished over time -- largely because no one was injured and no equipment was damaged at any time from the missile's impact to its recovery.

Based on the information that is available to date, our assessment is that the SCUD missile was "Definitely Not" armed with chemical warfare agents. This assessment is based upon the following information:

- that testing conducted for chemical warfare agents during recovery operations were negative.
- chemical agents were not found when the warhead was rendered "Safe."

### *Purple T-Shirt Event*

On March 19, 1991, following the cease fire, personnel from NMCB-24 required medical attention after becoming exposed to unidentified airborne noxious fumes. These fumes resulted in acute symptoms, such as burning throats, eyes and noses, and difficulty in breathing. In addition, portions of their brown T-shirts turned purple. It was also reported that portions of some of these same individuals' combat boots also turned purple.<sup>49</sup>

The incident occurred at approximately 1415 hours local and involved three separate groups of NMCB-24 personnel. Five individuals composed the first group, which was working on equipment in the Alpha Yard (a motor pool located adjacent to Camp 13).<sup>50</sup> Group two was two medical personnel, who were emptying sand bags inside Camp 13.<sup>51</sup> A third group was identified through eyewitness interviews and was composed of two other NMCB-24 personnel.<sup>52</sup> This third group experienced the same incident, but did not report it to the safety officer and did not report to the medical department for treatment.

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<sup>49</sup> NMCB-24 Command Post Log, op.cit.

<sup>50</sup> NMCB-24 Command Post Log, op.cit.

<sup>51</sup> NMCB 24 Sick Call Log, op.cit.

<sup>52</sup> Interview notes (Lead Sheet 1181).

Both of these individuals have been interviewed. One individual could not remember the incident. The second individual remembers donning his mask and continuing to work.

The position of each of the three groups was such that if one drew a line connecting their locations, the axis would be oriented roughly North to South as shown in Figure 9. Each group was separated from the adjacent group by about 0.25 km for a total spread of about 0.5 km from North to South. Figure 9 depicts the relative positions of the three "purple T-shirt" groups, the prevailing wind direction, and the location of air monitoring station number 1.<sup>53</sup>

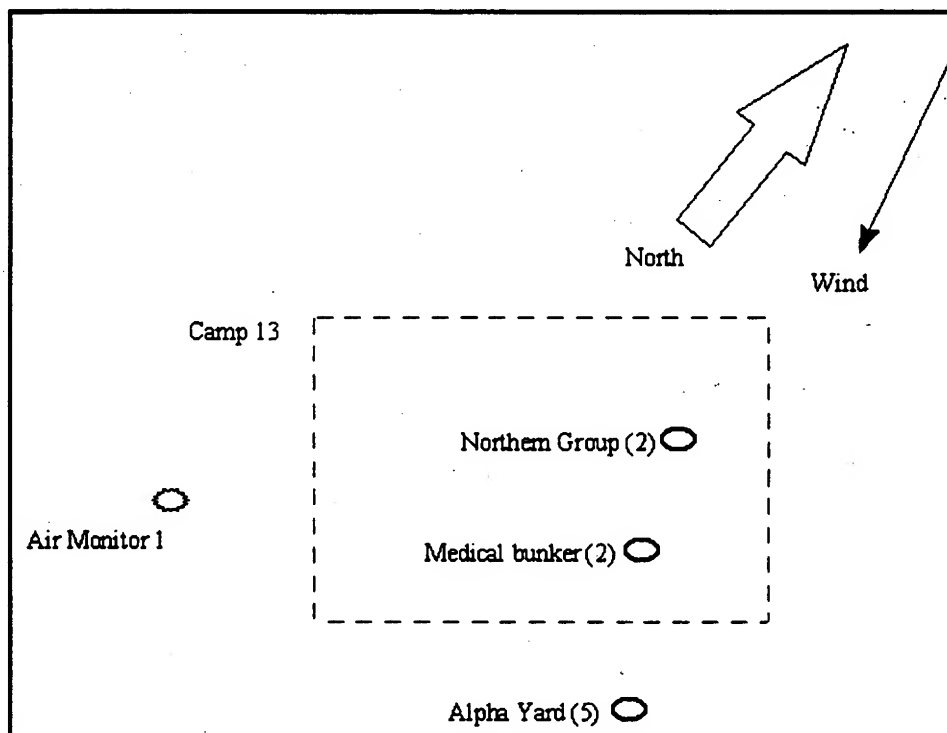


Figure 9. Purple T-Shirt Groups

The NMCB 24 personnel who were involved in the incident stated they experienced a choking sensation when a "noxious" cloud enveloped them. None of the affected personnel saw the origin of the gas cloud, but all believed the cloud came from one of the industrial plants located near Camp 13 as shown in Figure 10. Although they all agreed that the odor was not ammonia, each person described the odor differently -- chlorine, battery acid, nitric acid, methyl ethyl ketone. All experienced the same symptoms; all had their T-shirts change color. According to one eyewitness, "the areas of our T-shirts that were soaked with sweat slowly began to turn the most beautiful shade of purple I

<sup>53</sup> The actual wind direction is not known. As depicted in Figure 9, the wind direction was determined by interviewing the individuals involved in the incident.



ever saw."<sup>54</sup> All personnel, except for those in group 3, immediately sought medical attention and, after showering and changing clothes, returned to work with no further symptoms.

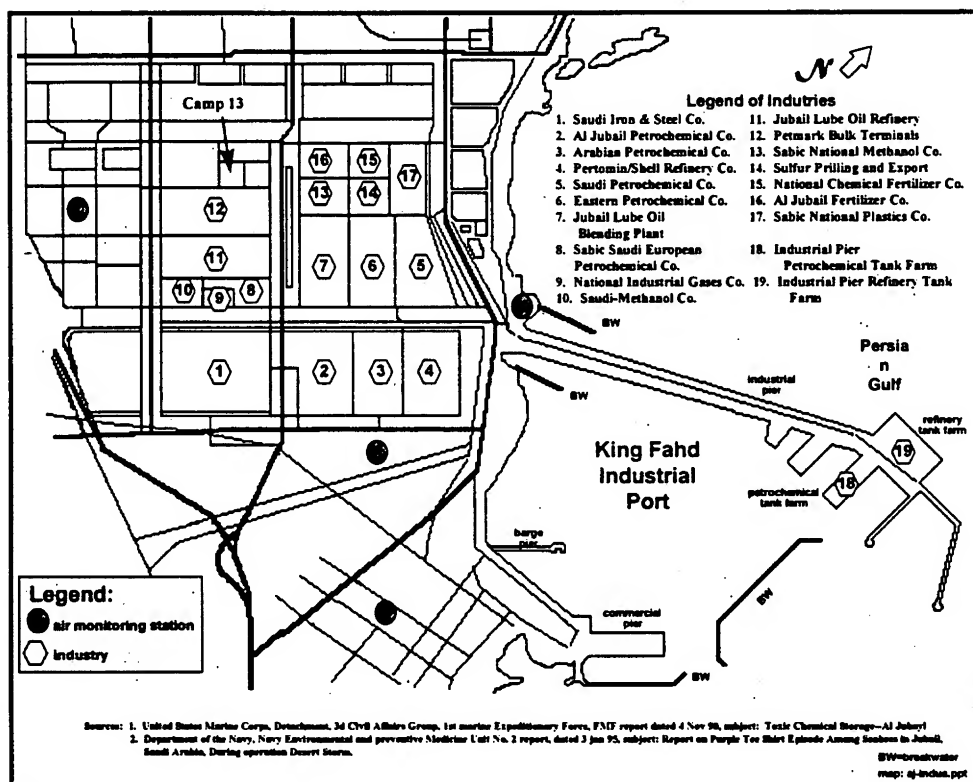


Figure 10. Camp 13 and Surrounding Industries

As stated earlier, none of individuals who were exposed to the noxious gas cloud saw where it came from. A Master Chief Equipment Operator (EQCM) from NMCB-24 was interviewed by telephone. This individual supervised the construction of Fleet Hospital-15, and worked on earth stabilization projects at KAANB. To date, the Chief is the only eyewitness that has positively identified the source of the noxious cloud. His comments concerning the purple T-shirt incident are summarized as follows:

There was an industrial accident connected with the purple T-shirt incident. The wind blew from the NW to the SE all of the time. It almost never changed. NMCB-24 studied the wind patterns, as they were concerned about gas attacks. The day of the purple T-shirt incident, the Chief was working at a site that was north of Al Jubayl. He

<sup>54</sup> Lead Sheet 181, op.cit.

returned to Camp 13 to check on equipment that had broken down. Immediately after stepping out of his vehicle at the Alpha yard, he saw purple dust falling everywhere. He could see it coming from a smokestack at the fertilizer plant. The winds changed 180 degrees when it dumped it on him. There were nose bleeds and there was gagging. He had a nose bleed. Although acid was stored in the Alpha yard, he does not recall a battery explosion at any time.<sup>55</sup>

When interviewed, NMCB-24 medical personnel stated that the contaminated clothing was bagged and turned over to the Marines (either 3d NCR or IMEF personnel), and a group of Saudi Arabian officials. Those individuals conducted an environmental/occupational hazard investigation after the incident. NMCB-24 medical personnel stated they were not aware of any official report that was prepared upon completion -- of the investigation. But they were aware that the unit received a telephone report supposedly from the same individuals who conducted the study -- to inform the unit that there were no problems and nothing to worry about.<sup>56</sup> Investigators are attempting to locate any report generated by either U.S. or Saudi Arabian officials relating to the analysis of the purple T-shirts. However, because a chain of custody for the T-shirts cannot be identified, it is unlikely that investigators will be able to determine the identity of the Marines or Saudi officials who took possession of the T-shirts, or to locate any reports that may have been prepared. A request for information concerning this event has been transmitted to the United States Defense Attaché Office, Riyadh, Saudi Arabia.

This incident has been associated with the possible release of fumes from a nearby industry or a localized chemical spill in the Alpha Yard that could have caused the T-shirts to turn purple. The U.S. Navy's Environmental and Preventive Medicine Unit No. 2 (EPMU-2) conducted an environmental/occupational hazard investigation and site visit of Al Jubayl in 1994.<sup>57</sup> EPMU-2 personnel toured Camp 13 and local industries, as well as meeting with members of the Royal Saudi Arabian Ministry of Health and managers of the local industries. This study noted that the air quality in Al Jubayl was monitored throughout ODS/DS. Records from the Saudi Arabian government indicate that the air quality of Al Jubayl was maintained within acceptable limits throughout ODS/DS. In addition, records from Air Monitoring Station No. 1 for March 19, 1991, do not indicate the detection of any noxious airborne fumes that exceeded normal parameters acceptable for this area (see Tab E).

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<sup>55</sup> Interview notes (Lead Sheet 1400).

<sup>56</sup> Lead Sheet 632, op.cit.

<sup>57</sup> Report, January 3, 1995, Officer In Charge, Navy Environmental and Preventive Medicine Unit (EPMU) No. 2; Report on Purple Tee Shirt Episode Among Seabees in Jubail, Saudi Arabia, During Operation Desert Storm.

The EPMU-2 study could not determine the source of the irritant. However, their report did note that the camp was located in a heavily industrialized area. It stated that emissions from a petrochemical plant or from the motor park itself may have been the source of the irritant. Eyewitnesses stated that at the time of this incident, the winds were blowing out of the North, from the direction of the fertilizer plant.

In July 1993, the U.S. Army Material Test Directorate, White Sands Missile Range, conducted tests on a T-shirt in an attempt to identify the cause of damage to the shirt.<sup>58</sup> The rationale for this second test and the requesting agency is not known at this time. The T-shirt was believed to be similar to the ones that turned purple but its actual origin is not known. The T-shirt had numerous small holes on its front and back. A Scanning Electron Microscope (SEM) was used to analyze damage to the shirt's fibers. The SEM analysis could not determine what specifically caused the damage to the T-shirt in question. However, the cause of the damage appeared to be chemical in nature. The test directorate had conducted a similar study in 1988. During this earlier study, fabric was exposed to various concentrations of sulfuric acid. The damaged fiber ends of the current T-shirt sample exhibit similar damage to those fibers exposed to sulfuric acid in the 1988 study.

A third study was done by Natick Research Development and Engineering Center in Natick, MA, at the request of the Defense Science Board. Natick conducted analyses of T-shirts that were similar to those that had turned purple at Camp 13. The T-shirts were furnished by one of the NMCB-24 members whose T-shirt turned purple. It is not known whether these shirts were actually worn during ODS/DS. These tests showed that brown military T-shirts of the type worn during ODS/DS do turn purple when exposed to acids, such as sulfuric (battery) acid and nitric/nitrous oxides from nitric acid.<sup>59</sup>

#### *Findings of the Purple T-Shirt Event*

On March 19, 1991, nine personnel from Naval Mobile Construction Battalion 24 (NMCB-24) were working at Camp 13 and were exposed to unidentified airborne noxious fumes. Although it has not been verified, the source of the fumes appear to be a fertilizer plant located near Camp 13. This exposure caused acute medical symptoms and caused portions of these individual's T-Shirts and combat boots to turn purple in color. At least seven of the nine personnel reported to the medical facility for treatment. After showering and changing their clothes all five returned to duty with no further symptoms. The two individuals who did not report to the medical facility simply continued to work and did experience the acute medical symptoms as the others. The shirts and boots that

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<sup>58</sup> Internal Letter, U.S. Army White Sands Missile Range, Material Test Directorate, July 20, 1993.

<sup>59</sup> Memorandum, U.S. Army Aviation and Troop Command Natick Research, Development and Engineering Center, Color Changes of T-Shirts Worn During Operation Desert Shield/Storm, 17 May 1994

changed color were given to unnamed U.S. and Saudi officials and have never been recovered. Analyses of T-Shirts that are similar to those worn during the war show that the shirts can change color when exposed to acids, such as sulfuric (battery) acid and nitric/nitrous oxides from nitric acid.

### *Assessment of the Purple T-Shirt Event*

Based on the information that is available to date, our assessment is that chemical warfare agents were "Definitely Not" involved in the Purple T-Shirt event. This assessment is based upon the following information:

- this event occurred after the cessation of hostilities.
- there is no record of hostile attacks occurring during this time period.
- the medical problems reported by the individuals involved and their rapid recovery is not consistent with exposure to chemical warfare agents.

The Purple T-shirt event served to highlight that Al Jubayl was a heavily industrialized city. This heavy concentration of industries meant that personnel who lived and worked in Al Jubayl could possibly have been exposed to a variety of industrial chemicals. During interviews of personnel who were stationed in Al Jubayl, investigators asked for each person's impression of Al Jubayl's environment. As might be expected, investigators received both positive and negative comments. To provide as clear a picture as possible of Al Jubayl and the surrounding area, the last section of this case narrative discusses Al Jubayl's environment.

### **Environmental Factors & Other Related Topics**

Eyewitness accounts from numerous personnel, as well as notations in NMCB-24 command logs, relate the presence of ammonia and sulfur odors in the air and give a general impression of Al Jubayl's environment. Some of these accounts are cited below:

A Boatswain's Mate Third Class (BM3) assigned to Port Security Unit (PSU) 301-B said that Al Jubayl was the dirtiest port he had ever seen. He attributed this to smoke from the oil well fires in Kuwait, crude oil floating in the water, and the various industrial plants located in the area.<sup>60</sup>

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<sup>60</sup> Interview notes (Lead Sheet 5311).

A Port Securityman Second Class (PS2), assigned to PSU-301-B, recalls the heavy concentration of black smoke from the oil well fires:

"Sometimes the smoke layer was so heavy it would obliterate the sun."

When asked about the general conditions of Al Jubayl, he indicated that the port was as clean or cleaner than many ports he has seen in the United States.<sup>61</sup>

A Chief Builder (BUC) assigned to NMCB-24 stated that the "Camp 13 area smelled like a giant Port-O-Let (portable toilet)."<sup>62</sup>

During the pre-deployment phase of ODS/DS, military planners became aware of the heavy concentration of industry in Al Jubayl. The large number of industrial complexes located within a relatively small geographic area was of special concern. Many of these facilities used, produced, or stored industrial chemicals that could pose a serious health risk to military personnel, if they were exposed. The large number of personnel and equipment that were scheduled to deploy and redeploy through Al Jubayl compounded the problem.

Beginning early in the deployment phase of Desert Shield and continuing through the post Gulf War period, the issue of exposure to toxic industrial chemicals in the city of Al Jubayl was an item of concern to the IMEF command element. As a result, several studies (which are cited throughout this section) were conducted to determine the state of day-to-day environmental protective actions taken by the Saudi government; to identify the chemicals involved; and to determine what action(s), if any, could be taken to reduce the likelihood of a large scale chemical exposure.

Despite its heavy industrialization, studies have confirmed that the Saudi Arabian Government had stringent environmental standards in place long before the commencement of ODS/DS. The city of Al Jubayl, together with Yanbu, "are believed to be among the most environmentally clean of any comparable urban concentrations in the world."<sup>63</sup> Within the Kingdom, environmental protection standards were developed by the Saudi Meteorological and Environmental Protection Agency (MEPA). Enforcement of these standards was the responsibility of a Royal Commission that was established to oversee operations within Al Jubayl and the surrounding area (see Tab F). It has been reported that the Saudi environmental standards parallel those of the U.S. Environmental Protection Agency (EPA).<sup>64</sup> A comparison of a small portion of U.S. EPA and Saudi (the Royal Commission) Air Quality Standards are provided in Table 1.<sup>65</sup>

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<sup>61</sup> Interview notes (Lead Sheet 5312).

<sup>62</sup> Interview notes (Lead Sheet 1281).

<sup>63</sup> Pamphlet, United Nations Environment Programme, Sasakawa Environment Prize, op.cit., p. 16

<sup>64</sup> EPMU-2 Report, op.cit

<sup>65</sup> EPMU-2 Report, op.cit

Table 1. Comparison of a Cross-section of U.S. and Saudi Environmental Standards

Pollutant	Time Period	U.S. Standard (ppm)	Saudi Standard (ppm)
Sulfur Dioxide (SO <sub>2</sub> )	1 hour	NA	.49
	3 hours	NA	.30
	24 hours	.14	.15
	365 days	.03	.32
Hydrogen Sulfide (H <sub>2</sub> S)	1 hour	NA <sup>1</sup>	.30
	24 hours	NA <sup>1</sup>	.15
Nitrogen Oxide (NO <sub>2</sub> )	1 hour	NA	.35
	24 hours	NA	.21
	365 days	.053	.05
Ozone (O <sub>3</sub> )	1 hour	.12	.12
NMOC	0600-0900	NA <sup>2</sup>	.25
Carbon Monoxide (CO)	1 hour	35.0	35.0
	8 hour	9.0	9.0
ISP PM10 <sup>3</sup>	24 hours	150 (ug/m <sup>3</sup> )	150 (ug/m <sup>3</sup> )
	365 days	50 (ug/m <sup>3</sup> )	50 (ug/m <sup>3</sup> )
Lead <sup>3</sup> (Pb)	3 months	1.5 (ug/m <sup>3</sup> )	1.5 (ug/m <sup>3</sup> )

1. No Federal Standard has been established. However, the State of California established an individual state standard of .03.

2. No Federal Standard has been established. However, the State of New York established an individual state standard of .24.

3. Standards are expressed in micrograms per cubic meter.

The Saudi Arabian Government strictly monitored and enforced environmental standards and closely controlled the licensing of businesses within the Kingdom. This was done mainly for social and religious reasons, but the Saudis also recognized the need to maintain a strong environmental protection program.

Before any business could establish an industrial operation in Al Jubayl, it had to prove that its facility could adhere to established environmental and pollution control standards. The Saudi government required businesses to submit an Environmental Evaluation Report (EER). For example, the applications for several paper mills were rejected because the applicants could not demonstrate the ability to comply with environmental and pollution regulations. Obtaining a license did not signify an end to a business's compliance responsibilities -- it was only the beginning. In order to ensure compliance, businesses that established operations were subject to continuous monitoring.

As a result of their efforts, the United Nations awarded the Saudi Royal Commission for Jubayl and Yanbu the "Sasakawa Award" in 1988 for their "excellent planning and implementation of environmentally sound management of the two industrial complexes."<sup>66</sup>

### *Analysis of Industries Located in Al Jubayl*

Prior to the Gulf War, the Center for Naval Analysis conducted for IMEF a detailed analysis of every industry located in Al Jubayl.<sup>67</sup> The study identified each industrial plant that produced, used, or stored potentially dangerous chemicals, as well as the names of the individual chemicals involved. The location of these industrial plants is shown in Figure 11. This study also included the development of several exposure scenarios simulating the leakage of chemicals due to sabotage or direct destruction. Table 2 identifies the primary industrial complexes and the industrial chemicals they use or produce.<sup>68</sup>

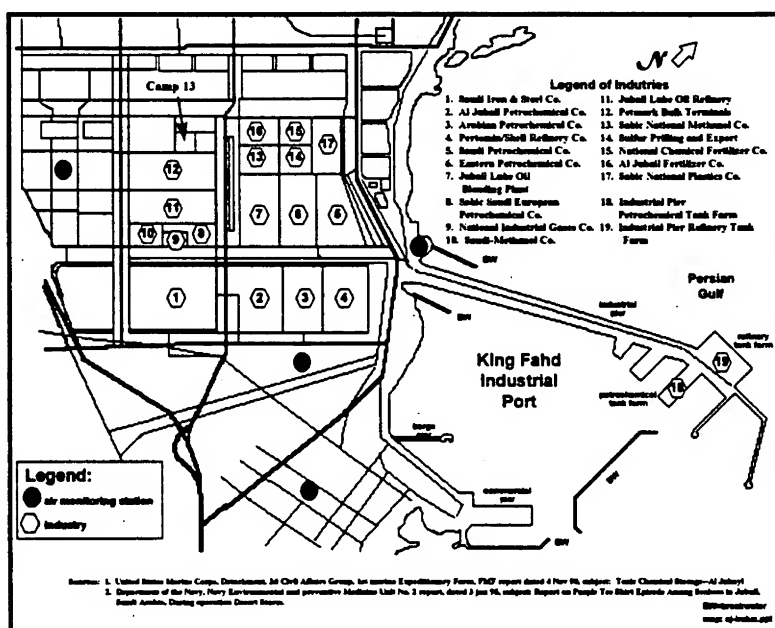


Figure 11. Identification of Industrial Plants Located in Al Jubayl

<sup>66</sup> The Sasakawa Environmental Prize is awarded under the auspices of the United Nations Environment Program. It is considered to be one of the most prestigious environmental awards in the world. The Sasakawa award is named after Mr. Ryoichi Sasakawa, who was a Japanese environmental philanthropist, and Chairman of the Sasakawa Foundation. Pamphlet, United Nations Environment Programme, Sasakawa Environment Prize, op.cit., p. 16

<sup>67</sup> Report, November 29, 1990, IMEF CNA Representative, Threat from Release of Chemicals Stored or produced in the Al Jubayl Area.

<sup>68</sup> EPMU-2 Report, op.cit.

Table 2. List of the Primary Industrial Chemicals Found in Al Jubayl

Chemicals Found Within Al Jubayl City		
Name of Complex	Chemical	Hazard
Saudi Methanol Co.	Methanol	Highly Flammable Liquid
Gas	Nitrogen Oxygen	Asphyxiant gas Increases Fire Risk
Fertilizer 1 (Ibn baytar)	Anhydrous Ammonia	Toxic liquefied gas
Sabic (Ibn Hayyan)	Caustic Solution Chlorine Ethylene dichloride Hydrochloric acid Vinyl chloride monomer	Corrosive liquid Toxic liquefied gas Highly flammable liquid Corrosive liquid Flammable gas
Sabic (Ibn Sina)	Methanol	Highly flammable liquid
Sabic (Ibn Zahr)	Butane Isobutane Butane-2 Methanol Methyl t-butyl ethanol	Flammable liquefied gas Flammable liquefied gas Flammable liquefied gas Highly flammable liquid Highly flammable liquid
Al Jubail Petro-chemical Co (Kemya)	Butane-1 Hexane-1	Flammable liquefied gas Highly flammable liquid
Arabian Petrochemical Co	Caustic Solution Diethylamine Ethylene	Corrosive liquid Highly flammable liquid Flammable gas
Arabian Petrochemical Co (cont.)	Propane Wash Oil	Flammable gas Flammable liquid
Petromin Shell	Benzene Caustic solution Di-isopropanolamine  Gasoline Kerosene Oils, low volatility Naptha Sulfur, molten	Highly flammable liquid Corrosive liquid Flammable liquid when dissolved in water. Highly flammable liquid Flammable liquid Flammable liquid Highly flammable liquid Flammable liquid at high temperature



Table 2. List of the Primary Industrial Chemicals Found in Al Jubayl (continued))

Saudi Petrochemical Co. (Sadaf)	Caustic Solution Chlorine Ethanol Ethyl benzene Ethylene Ethylene dichloride Hydrochloric acid Oils, low volatility Phosphoric acid Propane Styrene Sulfuric acid	Corrosive liquid Toxic gas Highly flammable liquid Highly flammable liquid Highly flammable liquid Highly flammable liquid Corrosive liquid Flammable liquid Corrosive liquid Flammable gas Highly flammable liquid Corrosive liquid
Al Jubayl Fertilizer Co. (Samad)	Anhydrous ammonia	Toxic gas
Eastern Petrochemical Co. (Sharaq)	Diethylene glycol Triethylene glycol	Flammable liquid Flammable liquid
<b>Chemicals Found Within Al Jubayl Port Facility</b>		
<b>Name of Complex</b>	<b>Chemical</b>	<b>Hazard</b>
	Vinyl chloride monomer Ethylene Styrene Ethyl alcohol Methanol Ethylene dichloride Ammonia Caustic solution Ethylene glycol	Flammable gas Flammable gas Highly flammable liquid Highly flammable liquid Highly flammable liquid Highly flammable liquid Toxic gas Corrosive liquid Flammable liquid

After the industrial chemicals were identified, they were grouped into three different classifications. Flammable substances, which encompassed the majority of the chemicals identified, were classified as Petrochemicals; ammonia and chlorine were classified as Toxic gases; and the remaining chemicals were classified as Corrosive liquids. Corrosive liquids received no further attention.

## Petrochemicals

The petrochemical companies located in Al Jubayl had disaster plans in place, and possessed varying capabilities to deal with explosions, leaks, etc. It was reported, however, that an explosion of a petroleum storage tank would have had serious consequences. Due to the percussion or impact of the explosion itself, extreme heat generated by the ensuing fire, and the rapid consumption of oxygen at ground level by the fireball, anyone within 500 feet of the blast would not have survived. Beyond the 500 foot zone the danger would have come from smoke, sulfur compounds, and airborne acids. In addition to explosion, a second danger would have been direct exposure to the petrochemicals themselves. This hazard would most likely have been the result of a major liquid petrochemical spill.<sup>69</sup>

## Toxic Gases

Toxic chemicals (gaseous forms) were the second category of hazardous substances to be studied. As with their petrochemical company counterparts, each company that dealt with toxic chemicals reportedly had disaster preparedness plans. Three toxic substances were studied: ammonia, chlorine, and hydrogen sulfide. Each is discussed separately in the following paragraphs.

Ammonia was stored at facilities located in both the city and at the port. Two companies stored ammonia in the city -- Fertilizer 1 and the Al Jubayl Fertilizer Company. Both companies reportedly reduced their holdings at the beginning of the Gulf crisis. For example, before the crisis Fertilizer 1 normally stored 22,000 metric tons (MT) of ammonia but reduced their holdings to 1,000-8,000 MT as the crisis progressed. The Al Jubayl Fertilizer Company stored up to 5,000 MT. When the quantity being stored reached 5,000 MT, the excess would be transferred to Fertilizer 1's tanks. The largest ammonia storage facility, operated by Fertilizer 1, was located in the port area. Their holdings at the port ranged between 5,000 to 20,000 MT between shipments, which normally occurred every two or three weeks.

Chlorine was located only within the industrial area of the city. The Saudi Petrochemical Company stored most of the chlorine. They voluntarily reduced their holdings to 110,000 MT at the beginning of the crisis.

Hydrogen Sulfide ( $H_2S$ ) was the third toxic gas that could have been injurious to coalition forces.  $H_2S$  could have emanated from any one of the numerous oil wells that dotted the area, or any one of the many oil pipelines that crisscrossed the area. If a pipeline or well head developed a leak or burst,  $H_2S$  could have been released into the environment.

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<sup>69</sup> IMEF CNA study, op.cit.

## Individual Protection from Petrochemicals and Toxic Gases

Would the M17A1 mask and MOPP suit have protected individuals if they had been exposed to petrochemicals or any of the aforementioned toxic gases? According to the U.S. Army's Field Manual 3-4, the M17A1 mask, when properly fitted, would have protected individuals against field concentrations of all known chemical and biological agents in vapor or aerosol form. The M17A1 mask would not have protected individuals from ammonia. When the oxygen level in the air is displaced by another gas (e.g., the air becomes saturated with chlorine after a rupture in a chlorine storage tank), the mask would not have protected the wearer. The MOPP suit, more commonly referred to as a Battledress Overgarment, would have protected the wearer against contact with chemical agent vapors, aerosols, and droplets of liquids. It was noted, however, that neither the mask nor MOPP suit could have provided protection if the air became saturated with either gas. Finally, both the mask and MOPP suit would have provided protection from exposure to hydrogen sulfide.<sup>70</sup>

Considering the findings of the original studies, contacts between representatives of IMEF and local officials were made in order to determine what actions could be taken to reduce the risk of exposure. At that time, IMEF representatives learned that businesses in Al Jubayl had voluntarily reduced their holdings of toxic substances at the beginning of ODS/DS. These meetings were also useful because they provided a forum to build a spirit of cooperation among the various parties involved. As a result, plans were developed that ensured proper notification of military authorities in the event of a disaster. These plans also included mutual aid agreements which would have involved military resources should the need arise.

Many Gulf War Veterans deployed in Al Jubayl expressed concern about the substances they could have been exposed to in such a heavily industrialized environment. The environmental data included in this narrative indicates that Al Jubayl is no worse (or better) than comparable industrialized sites in the United States. Environmental standards were in place in Al Jubayl, but chemical substances could have been inadvertently released—causing the T-shirts to turn purple and causing the Seabees to seek medical attention. That noxious cloud reported at Camp 13 could well have been such a release. The release could have come from the fertilizer plant (or some other nearby factory). We continue to search for information that will shed light on its origin.

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<sup>70</sup> Memorandum, Threat from Release of Chemicals Stored or Produced in the Al Jubayl Area, December 3, 1990.

## **SUMMARY**

This case narrative focuses on three major events that took place in Al Jubayl, Saudi Arabia, during Operation Desert Storm and Desert Shield. These events are the "Loud Noise" event, the "SCUD Impact" event, and the "Purple T-shirt" event. A general discussion of Al Jubayl's environment is also included because some veterans expressed concern over what hazardous materials they could have been exposed to while they were in Al Jubayl.

The information reported in this case narrative and the assessments made by investigators are based upon information that we have been able to uncover. We need to hear from you -- not only about your experiences in the vicinity of Al Jubayl, but also about any health problems you are experiencing which you think may be a result of your service during Operations Desert Shield /Desert Storm. If you have information that you believe would be of immediate value to us about the events at Al Jubayl, please call the DOD Incident Reporting Line at 1-800-472-6719.

If you are experiencing health problems you believe to be a result of your service in Operation Desert Storm/Desert Shield and you are eligible for health benefits through the Department of Defense, please call the COMPREHENSIVE CLINICAL EVALUATION PROGRAM at 1-800-796-9699.

If you are eligible for benefits provided by the Department of Veterans Affairs system, please call the PERSIAN GULF HELPLINE at 1-800-PGW-VETS.

## **TAB A - Methodology For Chemical Incident Investigation**

The DOD requires a common framework for our investigations and assessments of chemical warfare agent incident reports, so we turned to the United Nations and the international community which had experience concerning chemical weapons. Because the modern battlefield is complex, the international community developed investigation and validation protocols<sup>71</sup> to provide objective procedures for possible chemical weapons incidents. The standard that we are using is based on these protocols that include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation, or human or animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by an expert panel.

While the DOD methodology for investigating chemical incidents (Figure 5) is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, the methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. The major efforts in this methodology are:

- Substantiate the incident.
- Document the medical reports related to the incident.
- Interview appropriate people.
- Obtain information available to external organizations.
- Assess the results.

Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

To substantiate the circumstances surrounding an incident, the investigator searches for documentation from operational, intelligence, and environmental logs. This focuses the investigation on a specific time, date, and location, clarifies the conditions under which the incident occurred, and determines whether there is "hard" as well as anecdotal evidence. Additionally, the investigator looks for physical evidence that might indicate

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<sup>71</sup> "Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction," April 29, 1997. This Chemical Weapons Convention was opened for signature in Paris, France, on January 13, 1993. It has been signed by 165 States and ratified by 93 States (as of June 1997.) It was signed by the U.S. on Jan 13, 1993 and ratified on April 25, 1997. Part XI of the Convention, "Investigations in Cases of Alleged Use of Chemical Weapons," details some of the procedures. [<http://www.unog.ch/frames/disarm/distreat/chemical.htm>]

that chemical agents were present in the vicinity of the incident, including samples (or the results of analyses of samples) collected at the time of the incident.

The investigator searches the medical records to determine if personnel were injured as a result of the incident. Deaths, injuries, sicknesses, etc. near the time and location of an incident may be telling. Medical experts should provide information about alleged chemical casualties.

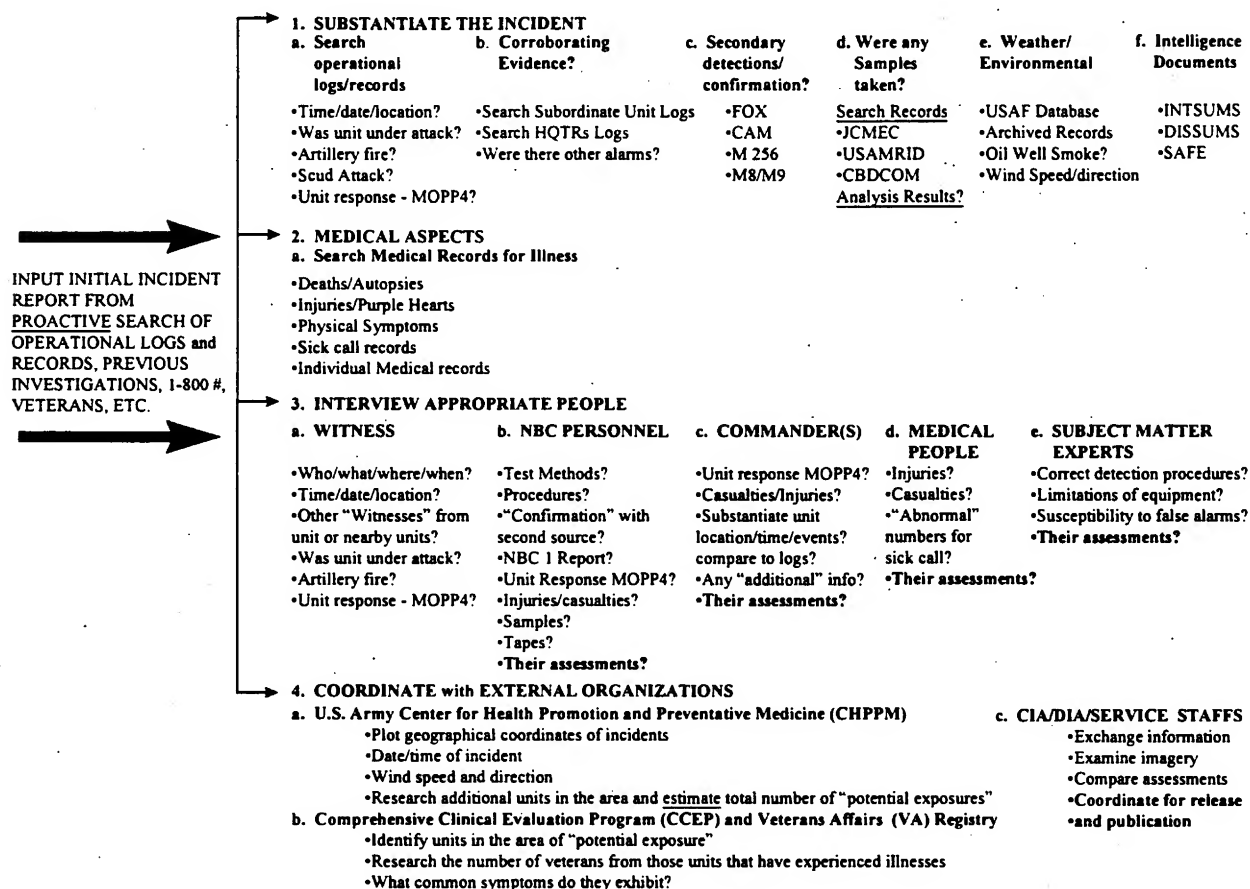


Figure 5. Chemical Incident Investigation Methodology

Interviews of incident victims (or direct observers) are conducted. First-hand witnesses provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved, and are particularly important if physical evidence is lacking. NBC officers or personnel trained in chemical and biological testing, confirmation, and reporting are interviewed to identify the unit's response, the tests that were run, the injuries sustained, and the reports submitted. Commanders are contacted to ascertain

what they knew, what decisions they made concerning the events surrounding the incident, and their assessment of the incident. Where appropriate, subject matter experts also provide opinions on the capabilities, limitations, and operation of technical equipment, and submit their evaluations of selected topics of interest.

Additionally, the investigator contacts agencies and organizations that may be able to provide additional clarifying information about the case. These would include, but not be limited to:

- Intelligence agencies that might be able to provide insight into events leading to the event, imagery of the area of the incident, and assessments of factors affecting the case.
- The DOD and Veterans' clinical registries, which may provide data about the medical condition of personnel involved in the incident.

## **TAB B - Acronym Listing/Glossary**

This TAB provides a listing of acronyms found in this report. Additionally, the Glossary section provides definitions for selected technical terms which are not found in common usage.

AO.....	Area of Operations
ATO.....	Air Tasking Order
AWACS.....	Airborne Warning and Control System
BM3.....	Boatswain's Mate Third Class
BUC.....	Chief Builder
CAM.....	Chemical Agent Monitor
CBR.....	Chemical Biological Radiological
CENTCOM.....	Central Command
CDO.....	Command Duty Officer
CFF.....	Critical Facility Force
DAO.....	Defense Attaché Office
DOD.....	Department of Defense (U.S.)
EER.....	Environmental Evaluation Report
EOD.....	Explosive Ordnance Disposal
EPMU-2.....	Environmental and Preventive Medicine Unit Number Two
EQCM.....	Master Chief Equipment Operator
ESG.....	Environmental Support Group
HDC.....	Harbor Defense Command
HMCS.....	Hospital Corpsman Senior Chief
HQ or Hq.....	Headquarters
IAD.....	Investigation and Analysis Directorate
IMEF.....	First Marine Expeditionary Force
JNAF.....	Jubayl Naval Air Facility
JCMEC.....	Joint Captured Material Exploitation Center
KAANB.....	King Abdul Aziz Naval Base
KM.....	Kilometers
KTO.....	Kuwaiti Theater of Operations
MAG.....	Marine Air Group
MAW.....	Marine Air Wing
MEPA.....	Meteorological and Environmental Protection Agency
MT.....	Measurement Tons
MOAW.....	Ministry of Agriculture and Water
MIUW.....	Mobile Inshore Undersea Warfare
MOPP.....	Mission Orientated Protective Posture
NMCB.....	Naval Mobile Construction Battalion
NAF.....	Naval Air Facility



1

## Glossary

### Detection Paper

Detection paper relies on certain dyes being soluble in chemical warfare agents. Normally, two dyes and one pH indicator are mixed with cellulose fibers in a paper without special coloring (unbleached). When a drop of chemical warfare agent is absorbed by the paper, it dissolves one of the pigments. Mustard agent dissolves a red dye and nerve agent a yellow. In addition, VX (a form of liquid nerve agent) causes the indicator to turn to blue which, together with the yellow, will become green/green-black.

Detection paper can thus be used to distinguish between three different types of chemical warfare agents. A disadvantage with the papers is that many other substances can also dissolve the pigments. Consequently, they should not be located in places where drops of substances such as solvent, fat, oil, or fuel can fall on them. Drops of water produce no reaction.

Depending on the spot diameter and density on the detection paper, it is possible to gauge the original size of the droplets and the degree of contamination.

*Reference: Detection of Chemical Weapons: An overview of methods for the detection of chemical warfare agents; homepage:*  
<http://www.opcw.nl/chemhaz/detect.htm>.

### Leishmaniasis

Leishmaniasis is a parasitic disease transmitted by sandflies.

*Reference: The Merck Manual, Sixteenth Edition, 1992, page 232.*

### M256A1 Chemical Agent Detection Kit

The M256A1 kit is a portable, expendable item capable of detecting and identifying hazardous concentrations of chemical agent. The M256 kit is used after a chemical attack to determine if it is safe to unmask. The M256A1 kit has replaced the M256 kit. The only difference between the two kits is that the M256A1 kit will detect lower levels of nerve agent. This improvement was accomplished by using an eel enzyme for the nerve test in the M256A1 kit in place of the horse enzyme used in the M256 kit.

*Reference: Worldwide Chemical Detection Equipment Handbook, p. 430.*

M8A1  
Chemical  
Alarm

The M8A1 is an automatic chemical agent detection and warning system designed to detect the presence of nerve agent vapors or inhalable aerosols. The M8A1 will automatically signal the presence of the nerve agent in the air by providing troops with both an audible and visible warning. The M8A1 was fielded to replace the wet chemical M8 detector with a dry system -- which eliminated the M229 refill kit, the logistic burden and associated costs. The M8A1 operates in a fixed, portable, or vehicle mounted configuration.

*Reference: Worldwide Chemical Detection Equipment Handbook, p. 412.*

Mission  
Oriented  
Protective  
Posture  
(MOPP)

The wearing of MOPP gear provides soldiers protection against all known chemical agents, live biological agents, and toxins. MOPP gear consists of the following items:

1. Overgarment (chemical suit)
2. Overboots
3. Mask (gas mask) with hood
4. Gloves

When a person is wearing MOPP gear, they can not work for very long nor can they work very fast. They may also suffer mental distress as a result of feeling closed in and will also suffer from heat stress and heat exhaustion when working in warm temperatures and at high work rates. The MOPP concept arose from the need to balance individual protection with the threat, temperature, and urgency of the mission.

Commanders can raise or lower the amount of protection through five levels of MOPP. In addition, commanders can exercise a mask-only option.

**MOPP Zero:** Individuals must carry their protective mask with them at all times. Their remaining MOPP Gear must be readily available (i.e., within the work area, fighting position, living space, etc.).

**MOPP Level One:** Individuals wear their overgarment. They must carry the rest of their MOPP gear.

**MOPP Level Two:** Individuals wear their overgarment and overboots and carry the mask with hood and gloves.

**MOPP Level Three:** Individuals wear their overgarment, overboots, and mask with hood. They carry the gloves.

**MOPP Level Four:** Individuals wear all their MOPP gear.

*Source: U.S. Army Field Manual 3-4, Headquarters Department of the Army, Washington, DC, 21 October 1985*

#### Mustard

Mustard "gas" refers to several manufactured chemicals including sulfur mustard. They do not occur naturally in the environment. The term gas is in quotes because mustard "gas" does not behave as a gas under ordinary conditions. Mustard "gas" is really a liquid and is not likely to change into a gas immediately if it is released at ordinary temperatures. As a pure liquid, it is colorless and odorless, but when mixed with other chemicals, it looks brown and has a garlic-like smell. Mustard was made in large amounts during World Wars I and II and used in World War I. It was reportedly used in the Iran-Iraq war in 1984-1988. It is not presently used in the United States, except for research purposes.

The only way that mustard can enter the environment (other than through use as a weapon) is through an accidental release. Some evaporates from water and soil into air. It does not easily go into water, and the amount that does breaks down quickly. It is more stable in soil than in water but still breaks down within days, depending on the outside temperature (cold weather makes it more stable). It does not go from soil to groundwater. Mustard "gas" does not build up in the tissues of animals because it breaks down so quickly. Mustard "gas" makes your eyes burn, your eyelids swell, and causes you to blink a lot. If you breathe mustard "gas," it can cause coughing, bronchitis, and long-term respiratory disease.

*References: Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for mustard "gas." Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.*

**TAB C - Units That Were Located in Al Jubayl or Deployed Through Al Jubayl<sup>72</sup>**

**NOTE: Unit Listings are too lengthy to include in the printed document (exceeds 500 printed pages). A sample listing is provided for coordination purposes. The complete list will be available on Gulfink.**

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<sup>72</sup> Based on locations reported for battalion-level Unit Identification Codes (UICs) derived from the Geographic Information System (GIS) [UIC-based personnel strengths from the Defense Manpower Data Center (DMDC)].

Date	Command	UIC	Unit	Location Name	Latitude	Longitude	Source
2 January 1991	HQ, 24TH MAR	14170HS	H&S CO (-) 2/24TH	NAF AL JUBAYL	27:01:26	049:32:54	2/24TH SITREP #13
15 January 1991	1ST SRI GROUP	20362HQ	2D INTEL CO HQTRS	CAMP #5	27:01:22	049:32:54	1ST SRIG S/R 15JAN91
15 January 1991	1ST SRI GROUP	20362PI	2D ITT	SWA	27:03:28	049:31:33	1ST SRIG S/R 15JAN91
15 January 1991	1ST SRI GROUP	20362PM1	2D MAFC	SWA	27:03:28	049:31:33	1ST SRIG S/R 15JAN91
15 January 1991	1ST SRI GROUP	20362PS	2D SCAMP	SWA	27:01:22	049:32:54	1ST SRIG S/R 15JAN91
15 January 1991	1ST SRI GROUP	20362PS1	2D SCAMP	SWA	26:53:14	049:47:48	1ST SRIG S/R 15JAN91
15 January 1991	1ST SRI GROUP	20362PS3	2D SCAMP	CAMP #3 R/R CENTER	26:53:14	049:47:48	1ST SRIG S/R 15JAN91
15 January 1991	HQ, 2ND AAV BN	21811HS	H&S CO (-) 2D AAV	CAMP #15 AL JABAYL	27:01:22	049:32:54	2D MAR DIV SITREP #31
15 January 1991	MWSG 37	00375HQ	H&S 37	KAAZ NAVAL BASE	26:56:42	049:42:38	3RD MAW SIT REPS
15 January 1991	MWSG 37	00271M	MWSS 271 (MAIN)	KING ABDUL AZIZ	26:56:42	049:42:38	3RD MAW SIT REPS
15 January 1991	HQ, 11TH MAR, FMF	11310AA	A BTRY 1ST BN 11TH MAR	AL JUBAYL	27:01:22	049:32:54	C/C 1/11 1JAN-28 FEB 91
15 January 1991	MWSG 37	375	MWSS 37	KAAZ NAVAL BASE	26:56:42	049:42:38	3RD MAW SIT REPS
15 January 1991	1ST SRI GROUP 1-2	21670	9TH COMM BN (-)	IST FSSG/PORT	27:01:22	049:32:54	SITREP/SRIG S-3
15 January 1991	1ST SRI GROUP 1-2	21670	9TH COMM BN (-)	KING ABDUL AZIZ	26:56:42	049:42:38	SITREP/SRIG S-3
15 January 1991	2ND TANK BN	21420	2D TANK BN	AL JUBAYL CAMP #15	27:01:22	049:32:54	2D MAR DIV SITREP #31
15 January 1991	2ND TANK BN	21420AB	B CO 2D TANK BN	AL JUBAYL CAMP #15	27:01:22	049:32:54	2D MAR DIV SITREP #31
15 January 1991	2ND TANK BN	21420HS	H&S CO 2D TANK BN	AL JUBAYL CAMP #15	27:01:22	049:32:54	2D MAR DIV SITREP #31
15 January 1991	2ND TANK BN	21420AC	C CO 2D TANK BN	AL JUBAYL CAMP #15	27:01:22	049:32:54	2D MAR DIV SITREP #31
15 January 1991	2ND TANK BN	21420AD	D CO 2D TANK BN	AL JUBAYL CAMP #15	27:01:22	049:32:54	2D MAR DIV SITREP #31

### **TAB D - SCUD History**

The SCUD was first deployed by the Soviets in the mid-1960s. The missile was originally designed to carry a 100-kiloton nuclear warhead or a 2,000 pound conventional warhead, with ranges from 100 to 180 miles. Its principal threat was its potential to hold chemical or biological agents.

It is directly descended from the German V-2. Its warhead is permanently attached to the missile body and thus has a high velocity impact. The first combat use of the SCUD occurred in 1973 in the Arab-Israeli Yom Kippur War. It was later used in the Iran-Iraq war of the 1980s.

"The Iraqis modified SCUDs for greater range, largely by reducing warhead weight, enlarging their fuel tanks and burning all of the fuel during the early phase of flight (rather than continuously). Such a SCUD therefore came down with a relatively heavy warhead and a heavy motor, separated by the light empty fuel tank. It was structurally unstable and often broke up in the upper atmosphere. That further reduced its already poor accuracy, but it also made the missile difficult to intercept, since its flight path was unpredictable.

The Iraqis had four versions: SCUD itself (180-km range), longer-range SCUD (half warhead weight, extra range attained by burning all propellant immediately rather than steadily through the flight of the missile), Al Hussein (650-km, attained by reducing warhead weight to 250 kg and increasing the fuel load by 15 percent), and Al Abbas (800-km, achieved by reducing warhead weight to 125 kg, with 30 percent more fuel). Al Abbas could be fired only from static launchers; all of the others could be fired from mobile or static sites. Only the original SCUD and the minimally modified version were particularly successful."

From: "Desert Victory -- The War for Kuwait" by Norman Friedman, Naval Institute Press, 1991:

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"The Israeli modified SCUDs for greater range largely by reducing warhead weight, enlarging their fuel tanks and burning all of the fuel during the early phase of flight (rather than continuously). Such a SCUD therefore came down with a relatively heavy warhead and a heavy nose separated by the empty fuel tank. It was structurally unstable and often broke up in the upper atmosphere. That further reduced its speed, poor accuracy, but it also made the missile difficult to intercept since its flight path was unpredictable.

The Israelis had four versions: SCUD itself (150-km range), longer-range SCUD (200 km), SCUD-C (250 km), and SCUD-B (300 km). All achieved immediately rather than steadily through the flight of the missile. A missile (650 km), attained by reducing warhead weight to 250 kg and increasing the fuel load by 15 percent, and Al Abbas (800 km) achieved by reducing warhead weight to 125 kg, with 30 percent more fuel. Al Abbas could be fired only from static launchers; all of the others could be fired from mobile or static sites. Only the original SCUD and the minimally modified version were particularly successful."

From: Desert Victory - The War for Kuwait, by Norman Friedman, Naval Institute Press, 1991.

Monitoring Station Number One  
Air Quality Summaries



# Environmental Survey Program

Jubail Industrial Complex  
Kingdom of Saudi Arabia  
Monthly AQ Summary

Final Data

Date - Aug 90

FOR Site - J1  
Page 1 of 4

Day	SO2			H2S			NO			NO2		
	AVG	MAX	PPB	AVG	MAX	PPB	AVG	MAX	PPB	AVG	MAX	PPB
1	---	---	---	---	---	---	---	---	---	---	---	---
2	---	---	---	---	---	---	---	---	---	---	---	---
3	0	0	0	0	0	0	1	5	18	7	15	15
4	0	1	1	0	0	0	1	2	10	2	17	19
5	0	0	0	0	1	1	---	---	---	---	---	---
6	---	---	---	2	9	21	3	25	31	5	15	20
7	0	0	0	1	4	1	1	4	20	3	19	19
8	---	---	---	---	---	---	---	---	---	---	---	---
9	1	1	1	2	12	24	1	5	28	5	24	21
10	---	---	---	---	---	---	---	---	---	---	---	---
11	1	1	1	---	---	---	---	---	---	---	---	---
12	0	0	0	1	3	22	1	4	11	2	9	19
13	---	---	---	---	---	---	---	---	---	---	---	---
14	0	0	0	0	2	10	1	2	10	3	16	24
15	---	---	---	---	---	---	---	---	---	---	---	---
16	0	1	1	0	0	3	1	3	12	3	22	19
17	0	1	1	0	1	23	1	2	22	2	16	22
18	0	1	1	1	5	24	1	2	18	4	7	20
19	0	0	0	2	9	23	1	5	43	7	21	21
20	0	1	1	1	2	3	1	4	7	1	19	19
21	0	1	1	0	3	5	1	3	9	1	19	20
22	0	0	0	0	0	0	1	5	16	4	9	24

## FOR Site - J1

Page 2 of 4

Date - Aug 90

23	0	0	2	1	22	24	1	4	19	3	9	1
24	0	0	22	1	13	23	1	1	10	3	13	22
25	0	1	2	2	16	23	2	6	11	6	27	23
26	0	0	24	1	3	3	2	6	19	9	31	23
27	0	1	2	1	3	3	3	14	8	10	27	23
28	0	0	0	1	7	21	1	5	12	8	24	20
29	0	1	22	0	2	23	3	9	16	7	27	23
30	0	1	5	2	7	19	1	6	10	5	24	17
31	0	1	2	3	7	3	1	4	7	4	13	15
#	24	24		24	24		23	23		23	23	
Avg	0	1		1	5		1	5		5	20	
Min	1	1		3	22		3	25		10	43	
Min	0	0		0	0		1	1		1	7	

Day	NOX				O3				NMOC				CO			
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX IIR	AVG PPM	MAX PPM	MX IIR	
1	---	---	---	---	---	---	---	---	---	0.1	0.5	21	---	---	---	
2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
3	8	23	15	24	34	19	0.00	0.01	21	0.2	0.3	11	0.2	0.3	11	
4	3	12	19	24	36	20	0.00	0.00	0	0.1	0.3	19	0.1	0.3	19	
5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
6	8	32	20	26	35	12	0.13	0.39	12	0.3	0.6	20	0.3	0.6	20	
7	4	24	19	28	38	17	0.07	0.16	19	0.2	0.4	19	0.2	0.4	19	
8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
9	5	29	21	34	50	10	0.17	0.23	21	0.2	0.7	21	0.2	0.7	21	
10	---	---	---	---	---	---	0.15	0.23	1	---	---	---	---	---	---	
11	---	---	---	---	---	---	0.14	0.20	3	---	---	---	---	---	---	
12	3	12	19	37	43	18	0.08	0.15	11	0.3	0.4	19	0.3	0.4	19	
13	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
14	3	10	24	35	45	11	---	---	---	0.2	0.4	24	0.2	0.4	24	
15	---	---	---	20	27	16	---	---	---	0.2	0.3	1	0.2	0.3	1	
16	4	14	19	13	20	15	0.10	0.24	8	0.3	0.4	19	0.3	0.4	19	
17	3	23	22	20	29	11	0.08	0.18	22	0.2	0.5	20	0.2	0.5	20	
18	4	18	20	25	39	18	0.10	0.21	20	0.3	0.5	20	0.3	0.5	20	
19	8	49	21	27	44	17	0.14	0.41	21	0.2	0.9	21	0.2	0.9	21	
20	2	11	19	33	45	11	0.18	0.24	9	0.2	0.3	22	0.2	0.3	22	
21	2	11	20	34	48	17	0.03	0.10	21	0.2	0.3	1	0.2	0.3	1	
22	5	17	24	34	50	13	0.05	0.15	21	0.2	0.4	20	0.2	0.4	20	
23	4	12	19	28	40	11	0.04	0.15	24	0.2	0.4	21	0.2	0.4	21	

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24	3	14	22	25	40	12	0.05	0.18	22	0.2	0.4	20
25	8	31	23	28	48	17	0.04	0.12	9	0.3	0.6	20
26	11	38	23	29	44	10	0.06	0.55	16	0.3	0.5	19
27	12	36	8	25	46	13	0.03	0.18	1	0.2	0.4	1
28	9	24	20	28	45	16	0.08	0.19	13	0.2	0.5	7
29	10	30	23	27	41	11	0.15	0.42	14	0.2	0.5	20
30	6	29	17	28	40	10	0.02	0.10	1	0.2	0.4	19
31	5	16	15	28	61	15	0.01	0.10	1	0.3	0.5	19
#	23	23		24	24		24	24		25	25	
Avg	6	22		28	41		0.08	0.20		0.2	0.5	
Min	12	49		37	61		0.17	0.55		0.3	0.9	
Min	2	10		13	20		0.00	0.00		0.2	0.3	

Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
1	0	1	2	1	15	3	3	25	7	13	23	15
2	0	0	2	2	17	3	1	5	19	9	19	19
3	0	2	2	2	17	3	1	7	10	9	31	19
4	0	1	3	2	19	3	1	8	19	13	30	22
5	0	1	24	1	16	3	1	6	19	14	34	23
6	1	1	3	1	16	3	1	3	7	10	26	1
7	0	0	3	2	4	21	0	2	19	0	24	23
8	0	0	0	3	19	3	3	20	23	10	40	23
9	0	1	20	2	16	3	2	11	15	13	30	20
10	0	2	11	1	4	5	4	13	15	14	37	21
11	0	0	0	1	3	7	2	0	0	14	29	2
12	0	3	5	0	2	15	2	12	15	11	26	19
13	0	1	12	1	20	23	4	12	22	10	40	22
14	0	1	2	1	12	24	2	10	11	9	23	24
15	0	0	2	0	1	1	4	14	15	10	23	1
16	0	1	2	0	0	5	1	9	10	9	19	20
17	0	1	2	0	0	0	1	4	9	7	20	19
18	0	2	2	0	2	3	2	0	9	9	31	20
19	0	1	2	0	1	3	1	5	17	9	21	20
20	0	2	2	0	2	3	3	20	7	12	20	7
21	0	1	2	0	2	23	1	3	21	9	10	22
22	0	2	2	2	3	0	1	3	18	9	14	7
23	0	2	2	0	0	3	2	0	10	11	33	19

Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
24	0	0	0	0	1	10	2	13	10	15	43	23
25	0	1	2	1	5	23	1	5	15	17	47	20
26	0	1	2	1	3	4	3	11	10	18	29	10
27	0	1	2	0	2	7	2	15	6	13	25	17
28	0	1	7	1	3	21	1	2	10	9	10	23
29	0	1	2	2	6	22	3	16	20	13	42	20
30	0	1	5	0	1	1	3	19	20	15	45	20
#	30	30		30	30		30	30		30	30	
Avg	0	1		1	7		2	10		12	29	
Min	1	3		3	28		4	25		18	47	
Min	0	0		0	0		0	2		7	14	

Day	NOX				O3				NMOC				CO			
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR	AVG PPM	MAX PPM	MX HR	
1	10	41	7	10	45	13	.02	.11	17	.4	.0	7	.4	.0	7	
2	4	21	19	24	37	10	---	---	---	.2	.5	19	.2	.5	19	
3	5	31	19	31	45	15	.08	.18	18	.3	.4	7	.3	.4	7	
4	9	37	22	25	41	12	.12	.34	20	.2	.5	20	.2	.5	20	
5	10	33	23	21	36	15	.03	.12	2	.2	.5	19	.2	.5	19	
6	5	22	1	34	52	15	.05	.19	19	.2	.4	19	.2	.4	19	
7	3	20	23	29	30	1	.17	.41	4	0.2	.4	19	.2	.4	19	
8	8	59	23	27	39	14	.19	.37	11	.2	.4	19	.2	.4	19	
9	10	30	20	25	38	14	.09	.20	14	.1	.5	7	.1	.5	7	
10	13	39	21	20	34	11	---	---	---	.2	.7	20	.2	.7	20	
11	11	30	19	21	34	11	.12	.18	7	.2	.7	20	.2	.7	20	
12	7	23	19	25	38	15	.13	.30	22	.3	.6	19	.3	.6	19	
13	17	50	22	---	---	---	.39	.75	23	.3	.5	19	.3	.5	19	
14	6	19	20	24	33	11	.60	1.11	24	.2	.5	7	.2	.5	7	
15	8	18	1	20	30	16	.40	1.07	1	.2	.4	20	.2	.4	20	
16	5	15	20	31	43	16	.00	.03	7	.2	.4	19	.2	.4	19	
17	3	18	19	33	45	15	.01	.07	7	.3	.5	20	.3	.5	20	
18	5	32	20	31	40	16	.00	.01	23	.2	.5	19	.2	.5	19	
19	4	19	17	29	39	10	.00	.00	7	.3	.6	20	.3	.6	20	
20	10	45	7	33	52	12	.00	.00	0	.2	.3	19	.2	.3	19	
21	4	16	21	31	46	16	.00	.00	.00	.2	.5	7	.2	.5	7	
22	4	11	18	30	43	16	.01	.04	11	.3	.5	21	.3	.5	21	
23	7	33	19	27	30	11	.12	.23	10	.3	.4	2	.3	.4	2	

Day	NOX				O3				NMOC				CO			
	AVG PPB	MAX PPB	MX HR		AVG PPB	MAX PPB	MX HR		AVG PPMC	MAX PPMC	MX HR		AVG PPM	MAX PPM	MX HR	
24	11	30	23		27	39	14		.04	.14	7		.2	.4	18	
25	12	44	20		30	62	18		.03	.09	12		.3	.7	22	
26	15	35	10		30	57	13		.03	.13	7		.3	.7	21	
27	9	31	6		20	38	15		.02	.00	.12		.3	.5	17	
28	4	11	23		23	38	17		.02	.10	24		.2	.4	19	
29	10	53	20		21	34	13		.02	.12	7		.3	1.1	20	
30	12	59	20		16	30	16		.01	.10	7		.3	1.2	20	
#	30	30			29	29			28	28			30	30		
Avg	8	31			26	41			.10	.23			.2	.6		
Min	17	59			34	62			.68	1.11			.4	1.2		
Min	3	11			16	30			.00	.00			.1	.3		



Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
1	0.	1.	2	1.	7.	22	2.	11.	19	12	38.	19
2	0.	1.	2	0	2.	20	3.	21.	9	10.	20.	19
3	0.	1.	2	1.	1.	1	2.	6.	7.	12.	25.	7
4	0.	2.	2	0.	1.	9	1.	5.	8.	12.	35.	14
5	0.	1.	2	0.	0.	22	1.	2.	19	9.	18.	22
6	0.	1.	2	0.	2.	16	2.	15.	10	8.	24.	19
7	0.	0.	2	1.	2.	12	2.	26.	15	12.	36.	20
8	0.	0.	24	2.	10.	22	3.	13.	10	10.	20.	19
9	0.	1.	2	0.	2.	22	5.	44.	19	18.	54.	19
10	0.	0.	2	1.	10.	22	3.	22.	14	14.	41.	19
11	0.	1.	23	1.	8.	24	3.	11.	23	11.	25.	23
12	1.	2.	8	1.	3.	8	1.	4.	8	8.	23.	2
13	0.	0.	10	1.	2.	21	1.	5.	8	11.	21.	15
14	0.	0.	2	0.	2.	3	1.	6.	8	10.	32.	17
15	0.	1.	22	0.	2.	21	2.	10.	8	9.	15.	14
16	0.	1.	2	2.	8.	23	5.	21.	22	13.	31.	22
17	0.	1.	22	1.	3.	22	1.	5.	19	7.	16.	23
18	0.	1.	2	1.	2.	6	3.	14.	10	10.	24.	24
19	0.	1.	22	0.	2.	22	2.	4.	15	10.	18.	12
20	0.	1.	2	1.	3.	8	3.	12.	7	12.	28.	15
21	0.	0.	0	1.	3.	3	3.	21.	11	8.	20.	11
22	0.	1.	24	1.	4.	6	2.	6.	14	9.	22.	14
23	0.	2.	2	1.	4.	3	2.	7.	8	8.	15.	14

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24	0.	0.	3	1.	2.	21	1.	4.	17	9.	23.	18
25	0.	1.	10	1.	4.	3	1.	12.	8	13.	25.	24
26	0.	1.	10	1.	6.	20	1.	5.	22	12.	35.	20
27	1.	1.	2	1.	2.	3	1.	30.	16	13.	32.	16
28	0.	1.	2	0.	3.	3	2.	13.	12	12.	34.	20
29	0.	1.	2	0.	1.	8	2.	12.	9	6.	16.	1
30	0.	1.	15	0.	0.	0	3.	12.	9	4.	9.	18
31	0.	0.	3	0.	0.	0	1.	4.	18	6.	17.	19

#	31	31	31	31	31	31	31	31	31	31	31	31
Avg	0.	1.	1.	1.	3.	3.	2.	12.	10.	25.	25.	25.
Max	1.	2.	2.	2.	10.	10.	5.	44	18.	54.	54.	54.
Min	0.	0.	0.	0.	0.	0.	1.	2.	4.	9.	9.	9.

Day	NOX				O3				NMOC				CO			
	AVG PPB	MAX PPB	MX HR		AVG PPB	MAX PPB	MX HR		AVG PPMC	MAX PPMC	MX HR		AVG PPM	MAX PPM	MX HR	
1	8	43	19		21	29	10		---	---	---		0.1	0.6	19	
2	7	26	9		29	41	17		.08	.12	24		.2	.4	21	
3	7	25	7		31	38	11		.05	.10	7		0.3	0.5	19	
4	7	31	14		38	79	14		-	-	-		0.3	0.5	6	
5	3	13	19		36	60	16		.02	.08	24		0.4	0.6	24	
6	5	21	19		33	41	16		.00	.04	7		0.3	0.4	6	
7	8	32	19		28	42	18		.03	.13	22		0.2	1.0	20	
8	6	17	19		26	39	17		.02	.11	7		0.4	0.6	19	
9	17	95	19		19	32	12		.04	.13	7		.3	1.1	19	
10	12	41	19		22	38	17		.10	.30	10		.3	1.0	19	
11	9	33	23		25	42	16		.06	.16	23		0.4	1.1	23	
12	5	19	2		26	42	16		.06	.12	9		0.4	0.6	2	
13	7	19	15		34	67	15		.04	.09	9		0.4	0.6	21	
14	8	32	17		31	54	16		.02	.08	20		0.3	0.7	1	
15	6	19	8		27	65	16		.04	.11	23		0.3	0.4	7	
16	14	51	22		19	48	15		.04	.17	21		0.4	0.9	21	
17	4	13	23		23	34	12		.02	.13	22		0.3	0.4	19	
18	10	24	18		27	43	16		.06	.19	12		0.3	0.5	20	
19	0	18	12		21	40	13		.06	.12	8		0.3	0.4	22	
20	11	34	15		19	53	14		.09	.23	15		0.3	0.5	6	
21	8	40	11		22	42	15		.07	.15	24		0.2	0.4	7	
22	7	26	14		22	40	15		0.05	.10	24		0.2	0.3	7	
23	5	15	14		23	42	14		.05	.12	22		0.3	0.4	22	

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24	6	26	18	30	58	24	.08	.16	20	0.3	0.5	18
25	12	26	24	24	54	18	.13	.25	19	0.4	0.8	19
26	10	36	20	-	-	-	.11	.32	17	0.2	0.5	18
27	15	63	16	25	58	18	.07	.16	18	0.2	0.5	18
28	10	38	20	19	35	16	.05	.18	19	0.3	0.5	3
29	4	17	9	25	38	17	.17	.57	23	0.3	0.4	1
30	3	11	9	32	37	15	.11	.48	10	0.3	0.3	1
31	3	19	19	31	42	16	.07	.11	7	0.2	0.4	19
#	31	31		30	30		29	29		31	31	
Avg	8	30		26	45		.06	.17		0.3	0.6	
Max	17	95		38	79		0.17	0.57		0.4	1.1	
Min	3	11		19	29		0.00	.04		0.1	0.3	

Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
1	0	0	19	1	6	21	4	15	19	7	32	19
2	0	0	0	2	4	24	2	11	22	7	30	21
3	0	1	23	0	2	1	2	10	9	12	30	24
4	0	2	2	0	2	22	4	30	11	10	25	22
5	0	1	22	0	2	23	4	27	22	9	30	22
6	0	1	21	1	3	21	8	74	21	11	42	21
7	0	0	0	0	1	14	3	10	8	11	33	24
8	0	1	21	1	3	21	2	15	1	11	39	21
9	1	2	2	1	2	3	0	2	8	6	23	2
10	1	2	2	2	4	20	2	11	8	10	27	20
11	0	1	24	1	2	1	2	12	23	9	37	23
12	1	5	13	1	2	19	3	15	24	9	33	24
13	0	0	8	1	2	8	7	77	8	6	29	0
14	0	1	11	0	1	17	1	0	15	1	6	18
15	0	1	2	4	40	8	2	9	9	2	11	19
16	0	1	11	0	1	15	1	3	16	0	3	7
17	0	1	15	1	4	23	2	13	17	2	12	18
18	1	3	9	1	3	7	3	17	17	5	25	18
19	0	6	10	1	3	20	4	10	9	9	37	19
20	1	2	12	1	1	1	2	9	19	6	25	19
21	0	1	2	2	5	9	2	5	8	11	36	22
22	0	1	4	1	6	22	4	19	9	14	43	22
23	0	0	23	1	9	4	2	14	23	8	37	23

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24	0	0	0	0	2	20	2	13	15	0	20	21
25	0	0	0	0	2	25	2	0	9	9	21	2
26	0	0	0	2	8	22	3	13	8	14	35	19
27	0	0	17	1	4	1	2	7	9	7	29	17
28	0	1	3	0	2	1	2	6	11	2	10	8
29	0	0	19	0	1	21	2	7	19	3	11	19
30	0	0	2	0	2	22	1	9	10	2	11	20
#	30	30		30	30		30	30		30	30	
Avg	0	1		1	4		3	16		7	27	
Max	1	6		4	40		8	77		14	43	
Min	0	0		0	1		0	2		0	3	

Day	NOX			O3			MX			NMOC			CO		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR	AVG PPM	MAX PPM	MX HR
1	10	47	19	16	26	10	.09	.2	19	.3	1.0	19	.3	1.0	19
2	9	40	20	20	45	16	.08	.15	22	.3	.7	21	.3	.7	21
3	14	39	24	26	48	17	.06	.11	14	.3	.6	23	.3	.6	23
4	14	40	11	24	45	14	.03	.10	7	0.1	0.3	19	0.1	0.3	19
5	14	64	22	22	44	13	.07	.3	22	.3	1.1	22	.3	1.1	22
6	10	116	21	23	42	11	.17	.5	21	.4	.2	21	.4	.2	21
7	4	24	19	28	38	17	0.07	0.16	19	0.2	0.4	19	0.2	0.4	19
8	13	49	1	22	45	17	.13	.19	21	.3	.6	21	.3	.6	21
9	7	23	2	36	76	15	.13	.21	16	.3	.5	5	.3	.5	5
10	12	32	7	25	43	3	.1	.21	10	.3	.5	7	.3	.5	7
11	10	49	23	20	34	15	.09	.21	23	.2	.8	23	.2	.8	23
12	12	40	24	21	34	17	.08	.14	23	.2	.6	24	.2	.6	24
13	12	106	8	23	37	16	.06	.13	24	.3	.8	8	.3	.8	8
14	2	10	15	33	41	14	.17	.84	15	.2	.3	12	.2	.3	12
15	3	15	19	35	46	13	.11	.27	8	.3	.4	19	.3	.4	19
16	1	4	7	30	50	14	.09	.15	14	.3	.3	1	.3	.3	1
17	3	23	17	35	45	16	.13	.21	15	.3	.4	7	.3	.4	7
18	8	34	18	32	48	14	.11	.28	19	.2	.4	18	.2	.4	18
19	13	54	19	25	60	12	.16	.24	13	.2	.5	19	.2	.5	19
20	8	33	19	25	39	15	.13	.18	7	.2	.5	19	.2	.5	19
21	13	40	22	27	55	15	.13	.21	22	.3	.6	22	.3	.6	22
22	18	43	22	33	69	16	.1	.2	4	.3	.8	22	.3	.8	22
23	10	51	23	32	59	16	.08	.3	23	.4	1.1	23	.4	1.1	23

24	11	31	20	31	49	15	.08	.18	24	.3	.6	20
25	12	28	2	27	46	13	.11	.16	19	.3	.4	1
26	17	46	8	28	51	16	.13	.18	7	.4	.5	3
27	9	35	17	25	40	20	.08	.13	17	.3	.6	2
28	4	16	8	30	40	18	.05	.11	14	.2	.4	24
29	4	18	19	31	39	13	.07	.12	15	.2	.3	1
30	4	12	10	36	45	12	.15	.3	10	.1	.3	7
#	30	30		30	30		30	30	30	30	30	
Avg	10	40		27	46		.1	.23		.3	.6	
Min	18	116		38	76		.17	.84		.4	2	
Min	1	4		16	26		.03	.1		.1	.3	



Day	SO2			MX			I12S			NO			NO2		
	AVG PPB	MAX PPB	HR	AVG PPB	MAX PPB	HR	AVG PPB	MAX PPB	HR	AVG PPB	MAX PPB	HR	AVG PPB	MAX PPB	HR
1	0	0	11	1	2	12	2	2	11	2	11	9	5	19	18
2	0	3	10	1	2	4	2	2	11	2	11	8	7	32	19
3	0	1	10	1	1	3	2	2	10	2	10	14	9	20	19
4	0	1	17	1	3	23	4	4	26	0	26	0	20	60	23
5	0	1	13	2	4	8	2	2	21	8	21	8	10	22	8
6	0	0	23	1	6	3	7	7	31	9	31	9	21	47	24
7	0	0	2	0	4	8	2	2	9	8	9	8	12	34	21
8	0	1	14	1	11	1	2	2	7	9	7	9	9	20	1
9	1	2	13	1	3	23	2	2	9	15	9	15	9	27	23
10	1	3	17	1	2	23	4	4	20	19	20	19	21	60	19
11	1	3	13	2	3	13	3	3	15	15	15	15	6	17	4
12	0	0	7	2	2	10	2	2	0	19	0	19	6	20	19
13	0	0	2	1	2	5	5	5	51	21	51	21	13	49	21
14	0	1	16	1	5	1	4	4	14	2	14	2	17	47	20
15	0	6	11	2	3	4	3	3	14	15	14	15	4	12	1
16	0	1	22	1	3	3	2	2	12	10	12	10	5	21	10
17	0	1	2	0	3	21	3	3	8	9	8	9	11	34	19
18	0	0	8	0	2	3	3	3	19	7	19	7	11	31	19
19	0	0	2	0	0	1	2	2	6	10	6	10	3	11	19
20	0	0	11	0	3	22	5	5	20	20	20	20	17	55	24
21	0	1	11	1	2	14	1	1	14	1	14	1	5	55	1
22	1	2	20	2	6	22	14	14	92	20	92	20	20	75	20
23	1	6	11	1	2	4	1	1	6	0	6	0	3	32	1

Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
24	1	2	15	0	2	0	5	26	19	16	48	19
25	1	4	15	0	1	21	4	22	1	7	48	1
26	0	0	3	0	1	5	4	11	14	4	15	8
27	0	1	17	0	0	3	3	16	15	2	12	17
28	4	21	10	0	1	22	1	5	11	1	9	24
29	7	34	9	1	2	23	4	19	19	12	43	19
30	2	8	13	0	2	1	3	17	18	15	42	19
31	1	6	17	1	10	3	9	32	23	25	55	23
#	31	31		31	31		31	31		31	31	
Avg	1	4		1	3		4	19		11	35	
Max	7	34		2	11		14	92		25	75	
Min	0	0		0	0		1	5		1	9	

Day	NOX				O3				NMOC				CO			
	AVG		MAX		AVG		MAX		AVG		MAX		AVG		MAX	
	PPB	PPB	HR	MX	PPB	PPB	HR	MX	PPMC	PPMC	HR	MX	PPM	PPM	HR	MX
1	7	23	10		36	52	15		.11	.15	.13		.2	.4		.7
2	9	42	19		31	43	13		.14	.22	22		.3	.6		20
3	11	37	19		29	50	15		.13	.23	7		.3	.6		19
4	24	71	23		25	54	15		.17	.38	23		.4	1.0		23
5	13	43	8		31	51	21		.16	.22	16		.3	.5		24
6	28	69	24		21	43	14		.19	.78	9		.4	1.0		24
7	15	38	22		22	43	14		.16	.24	8		.3	.6		1
8	11	24	19		28	55	16		.16	.22	17		.3	.5		19
9	11	28	23		32	47	16		.17	.23	14		.3	.4		7
10	25	80	19		21	4	16		---	---	---		.3	.7		.19
11	9	20	4		30	46	12		.14	.17	16		.3	.4		7
12	8	28	19		31	44	13		.15	.22	7		.3	.5		7
13	19	100	21		27	46	12		.18	.25	21		.3	.7		19
14	20	59	20		21	43	16		.10	.32	19		.3	.5		2
15	7	21	15		26	44	14		.14	.19	12		.2	.3		7
16	6	23	18		34	44	16		.15	.20	11		.3	.4		18
17	14	42	19		21	38	15		.16	.22	21		.3	.6		19
18	14	43	7		32	59	14		.18	.23	12		.3	.5		1
19	5	14	19		---	---	---		.19	.23	14		.2	.2		1
20	22	72	20		22	61	12		.22	.35	20		.4	.7		24
21	6	69	1		13	25	16		.13	.20	13		.3	.9		1
22	34	167	20		22	41	12		.16	.41	20		.3	.8		20
23	4	37	1		30	45	13		.15	.22	14		.3	.3		1

Day	NOX			O3			NMOC			CO		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR
24	21	74	19	22	38	15	.16	.25	19	.3	.7	.24
25	11	71	1	24	33	19	.15	.39	11	.3	1.1	1
26	8	22	8	31	41	15	.11	.16	10	.3	.3	1
27	5	22	15	33	43	20	.10	.17	17	.2	.3	3
28	2	9	24	34	49	17	.14	.19	11	.2	.3	13
29	16	63	19	---	---	---	.15	.23	23	.3	.5	19
30	18	56	19	25	45	15	.16	.23	7	.4	.6	22
31	33	87	23	16	36	15	.17	.38	23	.4	.8	19
#	31	31		29	29		30	30		31	31	
Avg	14	50		27	45		.15	.26		.3	.6	
Max	34	167		36	61		.22	.78		.4	1.1	
Min	2	9		13	25		.10	.15		.2	.2	

Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
1	3	8	15	2	4	15	6	25	8	29	63	18
2	0	0	0	0	1	15	2	4	9	1	4	8
3	0	0	0	1	3	11	3	14	20	5	25	22
4	0	0	0	1	3	11	3	14	20	5	25	22
5	0	0	0	1	6	13	2	12	18	6	21	8
6	0	1	3	1	4	19	2	10	19	5	26	19
7	0	2	24	1	3	22	5	26	24	11	38	23
8	0	1	13	1	4	1	4	15	10	18	37	22
9	0	1	14	1	3	5	5	19	10	17	36	4
10	0	1	16	1	2	16	2	5	10	5	13	2
11	1	1	11	1	2	4	2	9	23	7	31	23
12	0	1	3	1	2	1	3	18	12	12	33	12
13	0	1	3	1	2	1	3	18	12	12	33	12
14	1	1	12	1	2	15	1	6	11	1	8	11
15	0	1	5	1	2	4	1	9	15	1	8	19
16	0	0	2	0	2	23	4	27	24	11	41	22
17	1	2	22	0	5	5	3	11	9	13	26	6
18	1	2	2	1	3	23	2	15	6	11	34	6
19	0	0	16	1	3	18	1	6	19	7	35	18
20	1	3	6	1	4	6	2	8	11	3	12	24
21	2	7	7	1	3	9	2	9	16	4	12	1
22	0	3	2	0	1	21	2	8	8	2	13	8
23	0	1	2	0	1	3	2	9	9	1	2	8

Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
24	2	7	7	2	3	16	1	2	15	1	5	22
25	1	4	9	2	3	14	1	2	11	2	9	11
26	0	1	2	0	4	23	3	13	10	8	36	22
27	1	2	21	2	3	20	2	10	8	8	22	5
28	1	2	21	1	2	17	1	4	17	1	6	18
29	1	2	15	1	3	5	1	5	18	5	22	20
30	1	4	13	0	1	6	3	9	9	15	34	19
31	0	1	2	0	3	24	2	10	8	8	31	18
#	31	31		31	31		31	31		31	31	
Avg	1	2		1	3		3	11		8	25	
Max	3	8		2	6		6	27		29	63	
Min	0	0		0	1		1	2		1	4	

Day	NOX			O3			MX			NMOC			CO		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR
1	35	80	18	26	53	13	.16	.70	21	.7	1.0	7	.7	1.0	7
2	23	59	2	29	50	15	.10	.52	7	.4	.9	2	.4	.9	2
3	2	8	9	23	28	17	.00	.00	0	.2	.3	6	.2	.3	6
4	8	36	20	23	32	15	.07	.20	22	.3	.4	20	.3	.4	20
5	8	33	8	23	33	23	.11	.17	20	.3	.6	7	.3	.6	7
6	7	36	19	27	38	16	.10	.20	15	.2	.4	19	.2	.4	19
7	16	63	24	21	37	15	.13	.48	24	.3	.6	23	.3	.6	23
8	23	43	10	20	41	17	.12	.22	24	.3	.6	7	.3	.6	7
9	23	48	4	20	37	12	.07	.21	7	.4	.5	4	.4	.5	4
10	7	17	18	28	36	16	.04	.07	14	.3	.4	7	.3	.4	7
11	9	40	23	22	37	17	.10	.19	23	.2	.7	23	.2	.7	23
12	15	39	19	24	39	13	---	---	---	.3	.5	19	.3	.5	19
13	15	51	12	20	30	22	---	---	---	.3	.6	17	.3	.6	17
14	2	14	11	24	32	24	.10	.16	17	.2	.3	10	.2	.3	10
15	2	12	15	31	37	13	.11	.16	8	.2	.2	1	.2	.2	1
16	15	62	24	22	39	13	---	---	---	.2	.5	23	.2	.5	23
17	16	36	9	20	35	18	---	---	---	.2	.4	6	.2	.4	6
18	13	49	6	22	46	14	---	---	---	.3	.4	6	.3	.4	6
19	8	39	18	21	32	11	.01	.21	24	.3	.5	19	.3	.5	19
20	5	19	8	---	---	---	---	---	---	.3	.4	8	.3	.4	8
21	6	15	1	18	41	16	1.14	3.59	7	.3	.4	7	.3	.4	7
22	4	20	8	27	35	16	.08	.85	2	.3	.4	8	.3	.4	8
23	3	16	8	36	48	24	---	---	---	.2	.3	7	.2	.3	7

Day	NOX			O3			NMOC			CO		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR
24	2	6	22	37	48	1	.84	3.18	6	.2	.2	1
25	2	11	11	35	45	17	.91	4.43	8	.2	.3	8
26	11	48	22	29	42	14	.18	.69	11	.2	.6	22
27	10	31	8	---	---	---	.08	.25	21	.2	.4	7
28	2	9	18	48	56	13	.12	.47	20	.3	.3	12
29	6	23	20	32	43	13	.07	.14	7	.3	.4	7
30	17	37	19	28	51	16	.06	.15	13	.4	.5	19
31	10	37	18	31	49	15	.05	.13	1	.3	.5	1
#	31	31		29	29		24	24		31	31	
Avg	11	33		27	40		.20	.72		.3	.5	
Max	35	80		48	56		1.14	4.43		.7	1.0	
Min	2	6		18	28		.00	.00		.2	.2	



Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
1	0	0	0	1	1	10	1	3	8	1	4	1
2	1	4	6	0	1	3	2	6	12	4	15	19
3	2	2	6	0	2	19	1	11	10	4	12	8
4	2	9	13	1	2	19	1	3	20	1	5	20
5	0	0	24	1	2	23	2	11	9	1	5	8
6	0	0	2	1	2	7	2	8	8	6	25	20
7	0	0	0	0	2	3	2	6	10	4	23	8
8	0	1	6	0	1	19	1	4	19	0	1	9
9	1	5	13	1	2	6	1	7	9	5	28	19
10	1	2	12	0	0	0	1	4	11	2	10	23
11	1	3	12	0	1	15	2	6	9	7	20	21
12	0	1	23	1	2	21	1	3	8	3	12	23
13	3	12	9	2	4	5	1	4	18	5	19	19
14	1	8	21	2	3	18	1	5	18	6	20	19
15	0	5	24	1	3	1	2	9	21	8	35	21
16	1	17	12	1	3	3	4	15	4	-	-	-
17	0	2	12	0	1	11	1	4	15	10	28	19
18	1	3	19	1	2	20	4	44	8	10	42	8
19	3	9	11	1	4	15	6	19	7	11	31	7
20	0	0	0	1	2	10	3	18	10	9	26	10
21	1	4	11	2	4	23	4	26	7	3	25	7
22	0	2	14	1	3	21	2	7	24	6	32	24
23	0	0	0	2	5	11	6	25	16	19	38	16

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24	0.	3	15	2	5	8	7	48	8	13	35	9
25	0.	1.	16	1.	2	8	4	18	8	11	28	8
26	0.	1.	2	0	0	1	2	7	10	7	16	16
27	0	1	2	1.	3	11	2	13	15	8	18	15
28	2	7	11	2	4	13	2	5	9	1	10	8
#	28	28		28	28		28	28		27	27	
Avg	1	4		1.	2		2.	12.		6	21	
Max	3	17		2.	5		7	48		19	42	
Min	0.	0.		0.	0.		1.	3		0	1	

Day	NOX			O3			MX			NMOC			CO		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR
1	1	4	1	35	42	17	.02	.06	6	0.2	0.2	1	0.2	0.2	1
2	6	20	7	31	40	13	.13	.75	6	0.2	0.3	7	0.2	0.3	7
3	5	19	10	29	46	15	.07	.21	6	0.2	0.3	8	0.2	0.3	8
4	2	8	20	29	37	16	.04	.12	13	0.2	0.3	18	0.2	0.3	18
5	3	14	9	37	40	3	.04	.15	24	0.2	0.3	7	0.2	0.3	7
6	8	27	20	30	40	13	.05	.10	7	0.3	0.5	19	0.3	0.5	19
7	6	27	8	33	41	23	.02	.04	18	0.2	0.4	7	0.2	0.4	7
8	1	4	9	37	43	15	.03	.18	6	0.2	0.2	1	0.2	0.2	1
9	6	32	19	30	43	16	.17	.95	10	0.2	0.4	20	0.2	0.4	20
10	3	11	23	39	46	15	.03	.07	24	0.2	0.3	13	0.2	0.3	13
11	8	23	18	32	43	13	.05	.11	7	0.1	0.5	7	0.1	0.5	7
12	4	14	20	37	45	15	.07	.15	22	0.2	0.4	21	0.2	0.4	21
13	6	23	19	32	45	16	.15	.42	20	0.3	0.5	7	0.3	0.5	7
14	7	24	19	33	51	17	.23	1.08	21	0.3	0.4	7	0.3	0.4	7
15	10	44	21	30	49	17	.20	1.58	24	0.3	0.8	21	0.3	0.8	21
16	20	50	4	26	57	16	.15	1.51	1	0.3	0.5	8	0.3	0.5	8
17	11	30	18	29	43	13	.03	.06	21	0.3	0.4	3	0.3	0.4	3
18	14	86	8	24	38	17	--	--	--	0.3	0.8	8	0.3	0.8	8
19	16	50	7	28	50	14	.24	.99	10	0.3	0.6	7	0.3	0.6	7
20	12	44	10	28	42	16	.11	.24	15	0.3	0.5	10	0.3	0.5	10
21	6	51	7	29	39	16	.08	.47	11	0.2	0.5	7	0.2	0.5	7
22	8	40	24	23	45	17	.08	.30	24	0.2	0.5	21	0.2	0.5	21
23	25	63	16	9	17	2	.09	.26	19	0.3	0.6	16	0.3	0.6	16

24	20	75	8	18	34	13	.09	.35	14	0.3	0.5	6
25	15	46	8	26	37	16	.03	.08	12	0.4	0.6	20
26	10	19	16	31	43	12	.02	.09	24	0.2	0.6	22
27	10	31	15	31	40	14	.04	.12	1	0.3	0.5	13
28	3	14	8	29	41	24	.11	.72	10	0.3	0.4	2
#	28	28		28	28		27	27		28	28	
Avg	9	32		29	42		.09	.41		0.3	0.5	
Max	25	86		39	57		.24	1.58		0.4	0.8	
Min	1	4		9	17		.02	.04		0.1	0.2	

Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
1	1	5	23	1	2	16	1	6	11	3	9	21
2	0	1	1	1	3	14	5	54	16	8	32	21
3	0	1	23	1	2	3	7	31	19	18	43	19
4	0	1	13	0	2	1	3	12	18	9	20	1
5	0	0	2	2	20	12	1	5	18	4	19	18
6	0	2	23	1	2	18	2	8	15	4	19	20
7	0	2	4	0	2	23	1	4	17	2	6	18
8	0	0	15	0	1	3	2	5	11	7	17	22
9	1	13	15	1	4	22	3	11	12	14	34	13
10	0	2	17	2	3	15	2	8	9	5	21	2
11	0	0	4	1	3	3	2	13	7	5	24	7
12	0	3	22	0	2	22	2	14	22	9	22	20
13	2	4	11	2	4	20	2	6	12	15	29	17
14	1	2	7	0	1	22	3	11	10	5	17	22
15	0	2	3	1	5	7	8	58	12	9	30	23
16	1	2	6	1	13	16	7	38	14	12	29	7
17	0	3	10	2	3	12	3	7	15	11	32	22
18	1	7	14	2	6	1	8	39	8	22	37	8
19	1	6	15	0	1	21	2	8	9	17	28	18
20	0	2	10	1	4	22	1	5	18	8	30	18
21	0	1	23	1	6	24	5	17	21	12	37	21
22	1	3	15	1	3	1	3	9	14	12	25	22
23	0	0	0	0	2	21	4	13	15	13	24	14

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24	0	0	0	0	0	1	1	5	11	10	8	21	8
25	0	0	0	0	0	0	21	4	11	7	4	16	11
26	0	2	9	2	2	16	22	5	31	21	12	45	21
27	0	2	22	2	2	5	22	11	86	22	19	60	22
28	0	0	23	1	1	5	8	9	33	8	20	38	23
29	0	1	22	---	---	---	---	8	40	22	17	48	22
30	0	1	22	---	---	---	---	10	51	19	22	56	19
31	0	0	3	0	2	2	1	4	13	20	14	33	22
#	31	31		29	29	29		31	31		31	31	
Avg	0	2		1	4	4		4	21		11	29	
Max	2	13		2	20	20		11	86		22	60	
Min	0	0		0	0	0		1	4		2	6	

Day	NOX			O3			NMOC			CO		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR
1	4	10	21	31	41	20	.16	.69	23	.3	.3	1
2	13	66	16	26	45	14	.14	.62	23	.3	.7	21
3	25	74	19	17	31	17	.16	.39	17	.4	1.1	19
4	12	30	18	25	41	14	.04	.18	1	.3	.4	8
5	5	24	18	29	43	13	.02	.08	9	.3	.5	21
6	6	21	20	30	38	12	.04	.33	23	.3	.7	20
7	2	8	18	35	46	14	.07	.20	4	.3	.4	19
8	9	22	11	29	42	14	.12	.21	23	.3	.3	1
9	17	45	13	30	41	18	.08	.20	13	.3	.5	13
10	7	22	2	30	44	13	---	---	---	.3	.7	2
11	8	37	7	39	50	16	.00	.01	23	.3	.5	7
12	12	30	22	28	37	18	---	---	---	.3	.5	20
13	17	34	17	32	52	16	---	---	---	.4	.5	12
14	9	20	22	26	35	12	.04	.18	23	.2	.5	7
15	17	70	12	24	34	16	.06	.20	1	.3	.4	7
16	19	50	14	25	40	13	.04	.15	2	.3	.5	7
17	14	36	22	26	44	13	.07	.15	22	.3	.4	19
18	30	76	8	18	36	20	.10	.19	7	.4	.7	22
19	19	34	8	31	65	16	.07	.19	15	.4	.7	5
20	9	34	18	---	---	---	---	---	---	.3	.5	23
21	17	53	21	37	60	5	.11	.25	23	.2	.5	20
22	15	30	22	22	35	12	q---	---	---	.2	.4	22
23	16	34	15	25	33	20	.05	.13	24	.3	.5	14

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24	13	30	10	3	34	3	.06	.12	11	.3	.3	1
25	8	27	7	30	41	16	---	---	---	.3	.4	7
26	17	76	21	26	42	17	---	---	---	.3	.6	21
27	30	145	22	16	36	16	---	---	---	.3	1.2	21
28	29	69	8	15	36	16	---	---	---	.4	.6	20
29	25	89	22	16	40	16	---	---	---	.3	.7	22
30	33	106	19	16	34	14	---	---	---	.3	.8	19
31	18	46	20	21	43	13	---	---	---	.3	.7	20
#	31	31		30	30		19	19		31	31	
Avg	15	47		26	41		.08	.24		.3	.6	
Max	33	145		39	65		.16	.69		.4	1.2	
Min	2	8		15	31		.00	.01		.2	.3	



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Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
1	0	3	16	0	2	22	5	20	24	19	51	23
2	3	18	13	3	6	7	16	131	7	27	58	8
3	1	8	18	0	2	6	13	76	7	23	48	7
4	1	5	13	0	1	22	4	16	11	12	35	19
5	0	1	2	1	2	5	3	10	16	9	22	1
6	0	0	0	1	3	21	7	19	14	12	26	14
7	0	1	22	1	3	24	4	10	12	5	19	21
8	1	2	7	3	5	1	5	15	15	11	25	18
9	0	0	7	1	3	6	5	16	11	13	32	22
10	0	1	7	1	3	3	5	22	7	6	25	7
11	0	1	24	0	0	21	3	10	9	7	19	24
12	0	1	15	1	6	22	2	6	20	6	29	21
13	0	1	2	1	3	7	3	13	10	7	26	20
14	2	11	9	0	2	22	2	4	15	6	19	20
15	1	4	10	1	2	9	2	20	11	4	12	7
16	2	8	15	1	3	22	4	15	8	13	39	21
17	2	8	18	0	2	9	2	5	18	11	27	18
18	3	7	13	0	1	23	3	12	19	13	34	19
19	1	5	13	1	6	23	3	9	10	9	22	22
20	0	1	11	1	4	21	2	8	15	8	20	15
21	7	26	10	1	4	23	3	12	15	11	31	20
22	6	31	12	1	7	21	6	44	20	12	49	20
23	5	33	9	0	0	3	2	8	18	7	31	18

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24	5	16	10	0	2	24	7	39	20	14	47	20
25	1	5	14	0	2	22	3	8	18	16	29	17
26	1	4	12	1	3	22	2	18	21	13	43	21
27	0	1	23	0	2	1	2	6	8	2	10	17
28	6	31	5	0	2	4	3	10	7	6	23	20
29	6	31	5	0	1	1	2	5	19	11	29	22
30	4	14	16	1	10	23	2	7	15	10	27	21
#	30	30		30	30		30	30		30	30	
Avg	2	9		1	3		4	20		11	30	
Max	7	33		3	10		16	131		27	58	
Min	0	0		0	0		2	4		2	10	

Day	NOX			O3			NMOC			CO		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR
1	24	63	24	28	57	17	---	---	---	.3	.7	24
2	43	169	7	---	---	---	---	---	---	.5	1.0	1
3	36	123	7	38	58	18	.12	.81	15	.5	.9	7
4	16	39	19	36	59	14	---	---	---	.4	.6	19
5	13	30	16	28	40	8	.01	.04	12	.2	.5	1
6	19	45	14	22	34	24	.06	.23	11	.2	.3	7
7	9	25	7	---	---	---	.04	.47	15	.2	.3	6
8	15	34	18	18	31	20	.07	.20	17	.3	.4	7
9	18	41	11	21	30	16	.06	.15	22	.3	.7	19
10	10	47	7	32	44	22	.00	.04	15	.2	.5	7
11	10	20	24	34	45	16	.04	.34	24	.3	.4	20
12	8	31	21	36	51	17	.05	.16	1	.2	.5	21
13	10	28	10	35	50	17	---	---	---	.3	.3	6
14	8	21	20	42	53	13	---	---	---	.3	.3	.6
15	7	24	11	38	57	14	.00	.00	0	.2	.3	6
16	18	48	21	27	41	14	.08	.21	16	.3	.4	8
17	13	32	18	36	60	4	.05	.13	1	.4	.8	18
18	16	47	19	31	58	14	.04	.10	18	.4	.5	1
19	12	29	12	32	44	2	.01	.08	22	.3	.4	11
20	11	29	15	31	45	13	.04	.12	4	.3	.4	18
21	14	41	20	29	37	18	---	---	---	.3	.5	7
22	18	93	20	21	34	11	---	---	---	.3	1.1	20
23	8	39	18	28	42	13	.07	.15	18	.2	.5	18

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24	21	86	20	23	37	13	---	---	---	---	4	1.0	20
25	19	35	17	20	43	16	---	---	---	---	3	.5	24
26	15	62	21	33	59	12	---	---	---	---	4	.9	21
27	3	15	17	35	40	21	---	---	---	---	2	.3	2
28	8	28	20	29	39	15	.08	.19	23	---	3	.5	7
29	13	33	22	26	42	15	---	---	---	---	4	.5	18
30	12	31	21	28	48	16	---	---	---	---	3	.5	21

#	30	30	28	28	28	17	17	30	30	30
Avg	15	46	30	30	46	.05	.20	.3	.6	.6
Max	43	169	42	42	60	.12	.81	.5	1.1	1.1
Min	3	15	18	18	30	.00	.00	2	.3	.3

Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
1	11	42	12	4	12	23	11	57	21	12	27	14
2	3	12	13	3	5	1	1	6	7	2	7	2
3	8	34	8	3	7	3	0	0	9	0	1	2
4	7	42	10	1	3	10	1	3	20	5	24	20
5	4	12	6	0	2	10	2	4	19	5	19	23
6	2	16	9	1	2	4	1	5	18	5	21	18
7	2	10	10	1	4	10	2	5	18	11	33	20
8	5	23	19	1	10	22	26	163	21	16	49	19
9	5	32	15	0	3	32	6	25	19	12	34	19
10	4	19	10	1	4	6	2	9	20	5	23	20
11	6	34	10	2	10	22	2	10	19	9	33	20
12	2	10	11	10	63	19	1	4	17	7	20	17
13	0	0	1	1	3	23	2	7	16	9	25	23
14	0	0	0	0	2	21	4	12	21	10	29	21
15	1	5	16	1	8	17	9	51	22	15	37	21
16	4	9	21	1	4	4	5	24	7	17	34	19
17	1	2	2	1	3	7	2	5	10	3	15	10
18	0	0	23	0	3	1	1	2	8	1	4	21
19	3	21	11	2	4	8	1	3	7	2	9	7
20	6	23	9	1	9	21	2	7	18	6	26	19
21	1	5	13	1	4	9	2	9	7	8	20	19
22	0	2	9	0	2	5	3	7	8	4	20	9
23	0	0	0	0	0	0	1	3	16	1	9	19

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24	1	8	10	1	3	24	1	2	10	1	9	20
25	11	41	11	2	7	9	1	4	20	7	24	20
26	5	22	9	0	2	9	2	4	20	8	23	24
27	1	4	12	0	4	22	3	18	22	12	33	22
28	2	8	10	1	4	4	1	4	19	3	22	1
29	1	2	7	2	4	1	1	3	8q	1	8	20
30	1	6	7	1	3	22	1	5	7	2	8	7
31	0	0	0	1	2	22	1	2	7	0	0	0
#	31	31		31	31		31	31		31	31	
Avg	3	14		1	6		3	15		6	21	
Max	11	42		10	63		26	163		17	49	
Min	0	0		0	0		0	0		0	022	75

q

Day	NOX			O3			NMOC			CO		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR
1	22	75	21	17	32	4	---	---	---	.5	1.8	21
2	3	10	1	27	46	14	---	---	---	.3	.7	14
3	0	1	2	45	q54	13	---	---	---	.3	.5	2
4	6	27	20	41	56	15	.06	.13	14	.3	.6	20
5	7	20	20	28	39	11	.05	.21	21	.3	.4	19
6	6	26	18	29	43	13	.04	.07	24	.3	.5	20
7	14	38	20	26	45	11	.08	.41	20	.3	.5	20
8	41	212	21	21	38	14	.15	.55	21	.5	2.1	21
9	18	59	19	16	29	12	.12	.37	22	.3	.6	19
10	6	33	20	---	---	---	.08	.11	21	.2	.5	20
11	11	42	20	21	35	14	.02	.08	6	.3	.6	19
12	9	24	17	25	41	13	.00	.05	20	.3	.5	7
13	11	28	17	22	36	14	.11	.25	18	.3	.6	22
14	13	41	21	16	29	13	.02	.07	22	.3	.6	17
15	24	88	22	13	31	15	.06	.20	17	.4	.9	23
16	22	44	7	22	54	16	.04	.10	11	.3	.9	7
17	4	19	10	42	59	12	---	---	---	.3	.4	7
18	2	5	20	48	51	18	.09	.58	16	.3	.4	20
19	3	12	7	---	---	---	.01	.18	10	.3	.5	7
20	8	31	18	---	---	---	---	---	---	.3	.7	19
21	10	25	7	---	---	---	.12	.36	23	.3	.4	7
22	7	26	9	28	47	24	---	---	---	.3	.4	7
23	3	11	19	42	56	3	.10	.47	11	.3	.4	18

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24	1	10	20	32	41	16	.02	.09	1	2	.3	9
25	8	28	20	26	41	16	.04	.15	24	2	.4	20
26	10	24	24	26	40	11	.06	.14	7	2	.4	21
27	15	51	22	20	35	12	.04	.19	22	3	.9	22
28	4	24	1	33	43	14	.01	.13	7	2	.4	1
29	2	10	20	35	43	9	.00	.09	7	2	.3	4
30	3	13	7	35	43	9	.01	.11	7	3	.4	7
31	0	2	7	39	43	15	.00	.00	0	2	.3	17
#	31	31		27	27		25	25		31	31	
Avg	9	34		29	42		.05	.20		3	.6	
Max	41	212		48	59		.15	.58		5	2.1	
Min	0	1		13	29		.00	.00		2	.3	



Day	SO2			H2S			NO			NO2		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR
1	0	1	24	1	3	3	1	4	7	2	10	7
2	6	24	24	0	1	6	1	4	18	3	9	18
3	4	18	2	2	6	4	1	5	7	1	7	7
4	6	24	9	2	5	5	1	5	7	1	9	7
5	11	41	10	1	2	5	1	3	18	2	11	19
6	11	34	8	1	2	8	1	3	18	2	12	19
7	5	20	8	1	4	7	1	2	7	0	4	7
8	0	1	8	2	5	22	2	3	9	3	17	19
9	8	51	12	2	6	3	1	2	9	3	10	19
10	6	14	5	1	12	21	2	13	18	10	42	18
11	3	8	9	0	2	20	2	7	19	5	24	19
12	1	6	8	0	2	23	1	3	18	3	12	23
13	2	10	18	0	3	24	1	2	17	2	9	18
14	1	3	7	1	6	22	1	3	7	2	11	21
15	2	7	10	1	2	3	2	5	20	9	26	21
16	4	15	15	1	11	23	3	8	9	13	26	19
17	1	4	7	1	7	21	2	13	4	5	15	8
18	4	25	4	1	6	21	1	2	15	5	20	17
19	1	9	2	1	20	21	3	20	21	10	41	21
20	0	0	21	2	5	8	2	4	9	8	15	15
21	0	1	6	1	4	7	2	8	17	10	27	17
22	0	1	9	0	1	3	0	1	10	6	16	19
23	1	1	5	0	1	23	1	2	9	4	12	14

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24	0	1	24	1	4	6	2	12	15	5	20	15
25	1	2	22	2	5	3	1	5	7	13	34	15
26	1	2	7	1	4	7	2	21	7	14	30	17
27	0	1	24	1	2	4	0	2	6	8	20	18
28	0	1	2	4	16	4	0	1	13	0	4	13
29	0	0	0	2	9	20	1	2	18	5	20	19
30	0	3	12	2	17	21	1	5	18	9	30	19
#	30	30		30	30		30	30		30	30	
Avg	3	11		1	6		1	6		5	15	
Max	11	51		4	20		3	21		14	42	
Min	0	0		0	1		0	1		0	4	

Day	NOX			O3			NMOC			CO		
	AVG PPB	MAX PPB	MX HR	AVG PPB	MAX PPB	MX HR	AVG PPMC	MAX PPMC	MX HR	AVG PPM	MAX PPM	MX HR
1	3	14	7	31	40	11	0.0	.05	23	0.3	0.6	7
2	4	13	18	25	36	11	.02	.08	24	0.2	0.3	17
3	2	12	7	38	51	13	.02	.10	4	0.2	0.4	5
4	2	14	7	35	45	13	.02	.12	3	0.2	0.3	7
5	3	14	19	33	44	14	-	-	-	0.2	0.3	12
6	3	15	19	30	36	15	.02	.08	7	0.2	0.4	19
7	1	6	7	25	31	11	-	-	-	0.3	0.3	1
8	4	20	19	24	33	15	.10	.19	17	0.3	0.5	19
9	4	12	18	33	42	10	.02	.11	8	0.2	0.4	19
10	13	55	18	23	37	12	.05	.22	19	0.3	0.7	18
11	7	30	19	26	40	13	.05	.12	7	0.3	0.5	19
12	4	13	23	28	36	13	.01	.07	23	0.2	0.3	7
13	3	10	18	31	39	16	.01	.05	1	0.2	0.3	1
14	2	13	21	30	40	12	.01	.04	24	0.2	0.4	21
15	10	29	20	20	33	14	.02	.12	22	0.2	0.8	16
16	15	32	19	18	36	11	.03	.18	2	0.4	0.7	19
17	7	22	4	28	39	13	.02	.06	22	0.3	0.6	8
18	6	22	17	32	43	11	.04	.13	21	0.3	0.5	17
19	13	61	21	28	46	11	.04	.35	21	0.4	0.8	21
20	10	19	11	26	37	13	0.0	.00	0	0.4	0.5	7
21	12	35	17	25	36	4	0.0	0.0	0	0.4	1.0	23
22	7	17	19	19	35	16	0.0	.01	8	0.3	0.4	17
23	5	12	14	19	48	14	0.0	0.0	0	0.3	0.5	23

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24	7	32	15	18	40	18	0.0	.02	21	0.3	0.4	21
25	14	37	15	22	54	14	.02	.10	19	0.4	0.8	19
26	16	49	7	25	97	15	.02	.09	7	0.4	0.9	7
27	9	21	18	24	48	15	.01	.07	21	0.2	0.5	18
28	1	5	13	30	44	12	0.0	.04	13	0.2	0.3	13
29	5	20	19	25	43	15	.10	.31	19	0.3	0.6	19
30	9	32	18	28	48	15	.11	.23	19	0.3	0.7	19
#	30	30		30	30		28	28		30	30	
Avg	7	23		27	43		.03	.10		0.3	0.5	
Max	16	61		38	97		.11	.35		0.4	1.0	
Min	1	5		18	31		0.0	0.0		0.2	0.3	

## **Tab F -- Saudi Environmental Monitoring**

The Royal Commission developed an extensive monitoring system to detect pollutants in the air, ground water, sea water, and waste water. It has been reported that the monitoring staff was well qualified and used state-of-the-art equipment to monitor, compile, and analyze data on a regular basis.<sup>74</sup>

### **Air Quality Monitoring**

Eight remote sensor stations monitored the air quality within the vicinity of Al Jubayl. Seven stations were built at various locations within Al Jubayl, and the eighth monitoring station was located at KAANB. A mobile monitoring unit was also available. Monitoring stations that were located within the immediate industrial area and port area are shown in Figure 13. The fixed stations were composed of an equipment trailer and a sampling tower protected by a security fence. Each sampling tower had sensors installed at heights of 10, 50, and 90 meters. The entire monitoring process was automated. Data from sensors was entered into on-site computers and transmitted to a central monitoring station every five minutes. Data was compiled on an hourly, daily, monthly and yearly basis. Once compiled, data was compared to the Royal Commission's Standards.

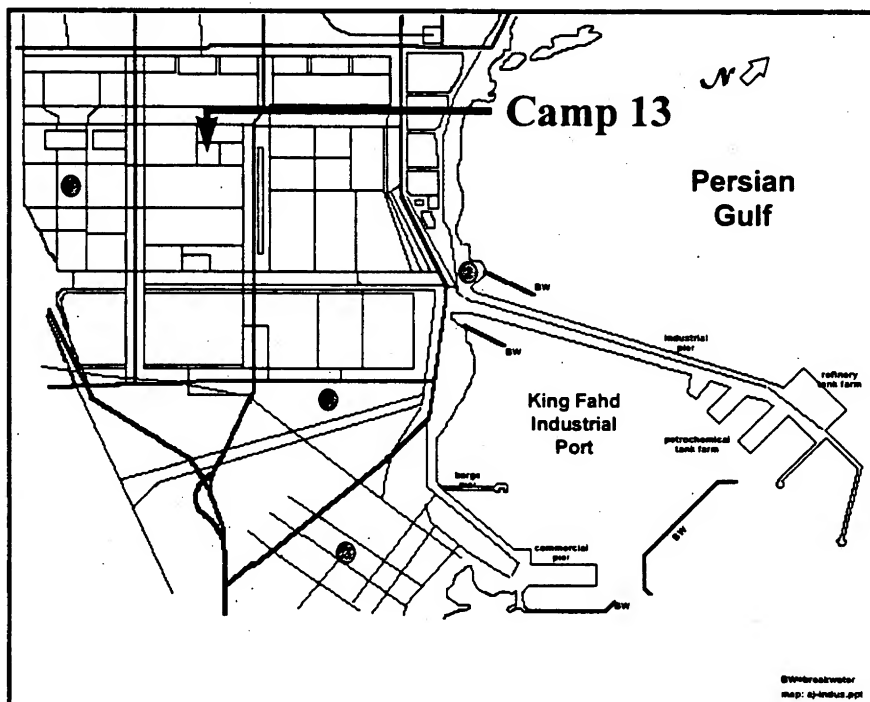


Figure 13. Location of Air Quality Monitor Stations within the Industrial & Port Areas

Monitors were capable of detecting the following pollutants:

<sup>74</sup> EPMU-2 Report, op.cit.

- a) Sulfur Dioxide (SO<sub>2</sub>)
- b) Hydrogen Sulfide (H<sub>2</sub>S)
- c) three different oxides of Nitrogen (NO), (NO<sub>2</sub>), and (NOX)
- d) Ozone (O<sub>3</sub>)
- e) Non Methane organic carbons (NMOC)
- f) Carbon Monoxide (CO)
- g) Inhalable Suspended Particulates (ISP PM10)
- h) Lead (monitoring for Lead began after ODS/DS).

It should be noted that the sensors were designed to detect industrial pollutants, and were not capable of detecting chemical warfare agents. All fixed sensor monitoring stations were operational throughout ODS/DS. As stated previously, Air Monitoring Station Number 1 was located 2 km west of Camp 13 (Figure 13). Readings taken by Monitoring Station Number 1 from September 1990 through June 1991 have been provided by the Royal Commission and are contained in Tab E. They show that in the area near Camp 13, there was no large-scale release of industrial chemicals or pollutants during ODS/DS.<sup>75</sup>

### **Water Quality Monitoring**

Water quality was also monitored using a system of ten strategically placed monitoring stations. The Royal Commission established water quality standards that paralleled those of the U.S. EPA. Water was monitored for total organic content, temperature, pH, total dissolved solids, and industry-specific pollutants. Waste water was treated at either an Industrial Waste Treatment Plant or a Sewage Waste Treatment Plant, as appropriate. Sanitary waste water was treated to bring it to a level that was near the quality of potable water and was then reused only for irrigation purposes.<sup>76</sup>

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<sup>75</sup> EPMU-2 Report, op.cit.

<sup>76</sup> EPMU-2 Report, op.cit.

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# Case Narrative

## Tallil Air Base, Iraq

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on events that occurred at Tallil Air Base. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events that occurred at Tallil. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997265-0000-018

Last Update: October 30, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1995 to investigate all possible causes. The Investigation and Analysis Directorate (IAD) of the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) assumed responsibility for these investigations on November 12, 1996 and has continued to investigate the events that occurred at Tallil Air Base, Iraq. IAD's interim report is contained here.

As part of the effort to inform the public about the progress of this effort, DoD is publishing (on the Internet and elsewhere) accounts related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling the accounts. The narrative that follows is such an account.

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## METHODOLOGY

During and after the Gulf War, people reported that they had been exposed to chemical warfare agents. To investigate these incidents and to determine if chemical weapons were used, the DOD developed a methodology for investigation and validation based on work done by the United Nations and the international community where the criteria include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation or human/animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by experts.

While the DoD methodology (Tab D) for investigating chemical incidents is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, our methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

By following our methodology and accumulating anecdotal, documentary, and physical evidence, by interviewing eyewitnesses and key personnel, and analyzing the results, the investigator can assess the validity of the presence of chemical warfare agents on the battlefield. Because information from various sources may be contradictory, we have developed an assessment scale (Figure 1) ranging from "Definitely" to "Definitely Not" with intermediate assessments of "Likely," "Unlikely," and "Indeterminate." This assessment is tentative, based on facts available as of the date of the report publication; each case is reassessed over time based on new information and feedback.

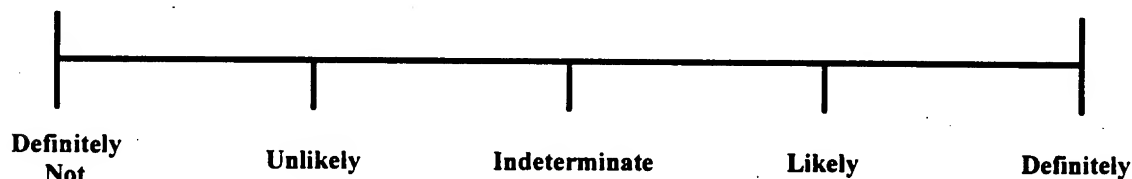


Figure 1. Assessment of Chemical Warfare Agent Presence

The standard for making the assessment is based on common sense: do the available facts lead a reasonable person to conclude that chemical warfare agents were or were not present? When insufficient information is available, the assessment is "Indeterminate" until more evidence can be found.

## SUMMARY

This investigation concerns the possible presence of chemical warfare agents (CWAs) at Tallil Air Base, Iraq.<sup>1</sup> Tallil was a major tactical air base in southeastern Iraq and a suspected chemical weapons (CW) storage site. During the 1980-88 Iran-Iraq War, fighter-attack aircraft from this base used CW against Iranian targets. The Iraqis were thought to have stored some of the CW used during this conflict in an S-shaped bunker at Tallil. For this reason, Tallil's bunker and 21 other S-shaped bunkers were assessed to support Iraq's national CW production and storage system. Consequently, these bunkers, and other facilities assessed to support Iraq's national CW programs, were given a very high priority during the Coalition's air campaign. A 2,000 pound bomb struck Tallil's S-shaped bunker in early February 1991—seriously damaging the bunker and partially collapsing the ceiling. During the cease-fire at the conclusion of Desert Storm, units of the 82<sup>nd</sup> Airborne Division occupied Tallil. Before their withdrawal from Iraq, US forces destroyed the facilities, equipment, and munitions at Tallil (and in the surrounding area) that were not damaged during air and ground phases of Desert Storm.

During the US occupation, chemical warfare personnel searched Tallil for CW using specialized chemical detection equipment (including Fox reconnaissance vehicles); Explosive Ordnance Disposal (EOD) personnel also joined in the search. Interviews with these individuals and the Combat Engineers who did much of the hands-on demolition work—in addition to a comprehensive review of available information (including national-level intelligence sources)—did not turn up evidence that chemical weapons or agents were present at Tallil during the US occupation. However, the extensive search did turn up significant quantities of CW-associated defensive gear like masks, suits, antidotes, and decontaminates. Due to pre-war briefings that Iraqi CW were painted certain colors or marked with color bands, some individuals believed that they had discovered, reported, or destroyed Iraqi CW. Post-war assessments of Iraq's CW program have confirmed that this identification method was totally unreliable. Instead, EOD personnel indicated that they relied on specific munitions design characteristics to identify CW, but that no system by itself was considered 100 percent accurate.

Iraq did not declare this facility to be a chemical weapons storage site under United Nations Resolution 687, which required Iraq to declare all weapons of mass destruction, along with their research, testing, production, and storage facilities for verification, monitoring, and demolition purposes. UNSCOM has not found evidence that chemical weapons were moved to Tallil before or during the Gulf War, and the UNSCOM team that inspected Tallil and its S-shaped bunker in December 1992 did not find evidence of chemical weapons or bulk agents. It is important to

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<sup>1</sup> The Ammunition Storage Point (ASP) located just to the northeast of Tallil Air Base is a separate installation known as the An Nasiriyah SW ASP (see Figure 3). Many of the individuals and units that were at Tallil also conducted similar activities at this nearby ASP. A case narrative on this ASP will be published in the future. Battle position 101 (BP101), which is mentioned in a study referred to as the MITRE report (*Iraqi Chemical Warfare: Analysis of Information Available to DoD*, Department of Defense Intelligence Oversight Committee Report, Classified Draft, June 1997), is a large area in the open desert located to the south of Tallil Air Base and the multi-lane highway known as Highway 8. BP101 is not part of this Tallil narrative, but may be considered for investigation in the future.

note, however, that neither the US occupation forces nor the UNSCOM team was able to inspect the portion of the S-shaped bunker where the ceiling had collapsed or examine any materials buried under the remaining debris. After the war, the Iraqis cleared the intact area of the bunker of rubble and used it for storage of conventional munitions. If the Iraqis were storing chemical weapons or agents in this facility at the time it was struck during the war, the resulting contamination almost certainly would have required the Iraqis to completely remove all bunker debris, extensively decontaminate the area, and then rebuild before using the bunker for conventional storage. This was not done. Given the preceding facts, combined with the lack of any US reports of chemical warfare agent detections or chemical warfare agent injuries, we find it unlikely that chemical weapons or agents were present at Tallil Air Base during the period of US occupation in 1991.

## **NARRATIVE<sup>2</sup>**

### **Background on Iraq's Chemical Weapons Program**

During the Iran-Iraq War (1980-1988), Iraq developed the ability to produce, store, and use chemical weapons against Iranian targets. These chemical weapons included tear or riot gas (CS), mustard blister agent (H), and G series nerve agents like Tabun (GA) and Sarin (GB). These agents were built into various offensive munitions—122mm unguided artillery rockets, 130mm and 155mm artillery shells, and 250 and 500 kilogram aerial bombs delivered by fighter-attack aircraft.<sup>3</sup>

Desert Shield and Desert Storm intelligence assessments indicated that Iraqi aircraft mainly used 250 and 500 kilogram bombs to deliver chemical agents. During the Iran-Iraq war, fighter-attack aircraft dropped mustard-filled and Tabun-filled 250 kilogram bombs and mustard-filled 500 kilogram bombs on Iranian targets. Other reporting indicates that Iraqi helicopters may have dropped 55-gallon drums filled with unknown agents (probably mustard) from altitudes of 3,000-4,000 feet. The Iraqis also used spray systems: they mounted two spray tanks (each with a volume of 1,000 liters) on the underside of an unknown number of helicopters.<sup>4</sup>

At the start of the Gulf War, US intelligence believed that certain types of Iraqi bunkers were used to store chemical and biological weapons.<sup>5</sup> Intelligence believed that Iraqi chemical weapons (or biological weapons) storage facilities had ventilation, security, and/or structural characteristics not seen in facilities storing conventional weapons.<sup>6</sup> During the Iran-Iraq War, these characteristics were used to identify newly constructed ammunition storage bunkers as likely repositories for chemical and biological weapons. The S-shaped bunker design was one of several types assessed to be associated with the storage of CW. Iraq had 22 of these S-shaped bunkers in what was assessed as their national level CW storage complex; one of which was

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<sup>2</sup> An acronym listing/glossary is at Tab A.

<sup>3</sup> Message, Subject: Iraqi Air Force Capability to Deliver Chemical Weapons, December 1, 1990.

<sup>4</sup> Message, Subject: Iraqi Air Force Capability to Deliver Chemical Weapons, December 1, 1990.

<sup>5</sup> Message, Subject: Iraqi Chemical Warfare (CW) Facilities and Storage Areas, December 19, 1990.

<sup>6</sup> Message, Subject: Iraqi Chemical Warfare (CW) Facilities and Storage Areas, December 19, 1990.

located at Tallil.<sup>7</sup> After the war, intelligence found that the Iraqis stored chemical weapons in a variety of bunkers—or even in the open. During the war, however, intelligence assumed CW would be stored in these S-shaped bunkers.



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Figure 2. Selected Iraq CW production and storage locations

### Tallil Air Base Description

Tallil Air Base is located in southeastern Iraq, approximately 160 miles southeast of Baghdad and 140 miles northwest of Kuwait City (see Figure 2). This facility had a prominent role during

<sup>7</sup> Message, Subject: Iraqi Chemical Warfare (CW) Facilities and Storage Areas, December 19, 1990.

the 1980-88 Iran-Iraq War. Fighter-attack aircraft and helicopters from Tallil conducted numerous strikes against Iranian targets—some using chemical weapons.<sup>8</sup> Tallil has two major runways and associated support facilities, including hardened bunkers to shelter aircraft and aircraft ordnance (see Figure 3). This base also has one of the S-shaped bunkers which, at the time, was assessed to store chemical weapons.<sup>9</sup>

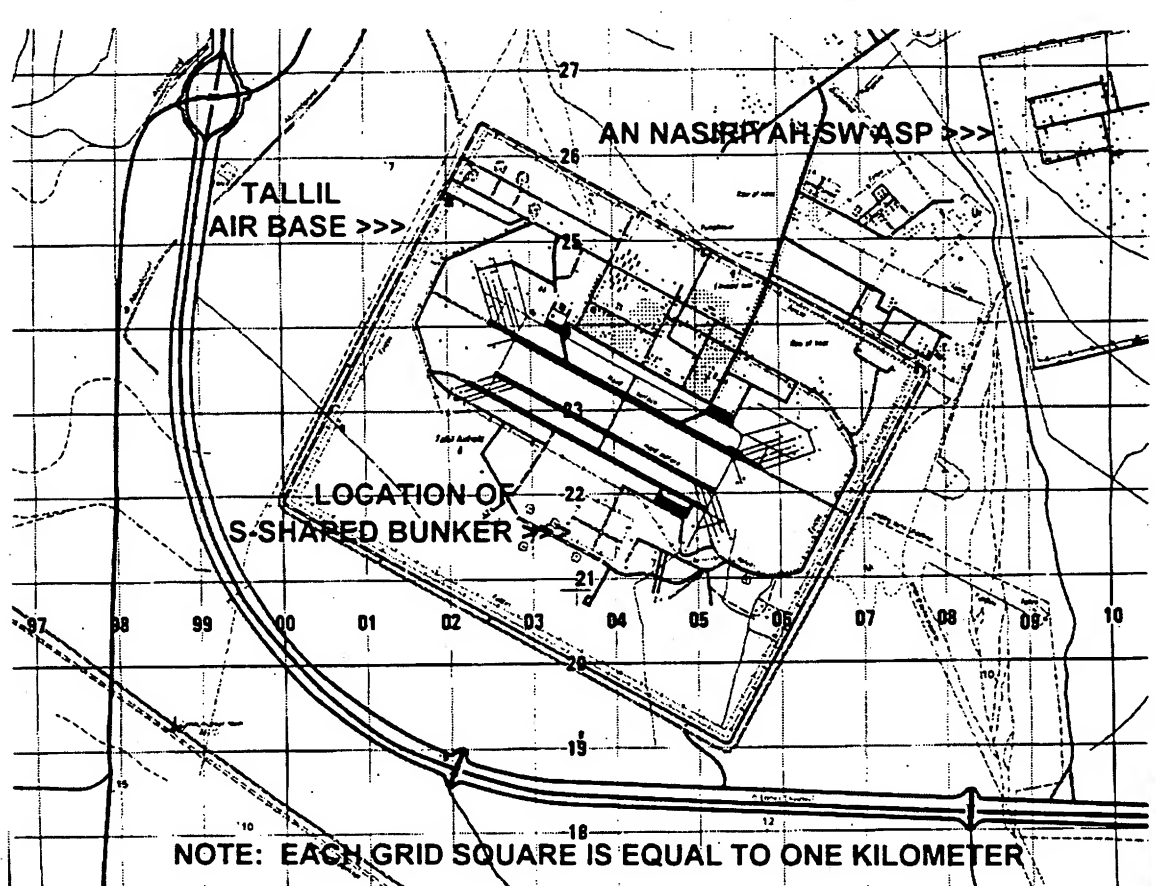


Figure 3. Tallil Air Base

### Desert Storm—the Air War

The destruction of chemical weapon production and storage areas was a high priority during the Desert Storm air campaign from January 17 to February 28, 1991.<sup>10</sup> In early February, the S-shaped bunker at Tallil suffered moderate damage in an air strike which partially collapsed the roof.<sup>11</sup>

<sup>8</sup> Intelligence Document, Subject: Iran-Iraq Frontline.

<sup>9</sup> Message, Subject: Iraqi Chemical Warfare (CW) Facilities and Storage Areas, December 19, 1990.

<sup>10</sup> DIA, Subject: Response to RII-2093, February 7, 1991.

<sup>11</sup> DIA, Subject: BW/CW bunkers, February 16, 1991.

A February 7, 1991, Defense Intelligence Agency message sums up the intelligence community's assessment of where Iraq had dispersed and stored their CW stockpile after several weeks of coalition airstrikes:

We do not know with any degree of confidence where the Iraqis are storing their chemical weapons in the KTO (Kuwait Theater of Operations). Traditionally, Iraq has not deployed its chemical weapons to forward based units until their use was imminent. Since the coalition's bombing campaign against Iraqi chemical production, storage, and filling facilities began on January 17, 1991, it is believed that they have probably dispersed their sensitive chemical weapons stocks to improve survivability. The current whereabouts of their chemical inventory is unknown.<sup>12</sup>

### **Desert Storm—the Ground War**

At the start of the ground war, a message from the XVIII Airborne Corps warned subordinate units of their responsibility concerning suspected chemical and biological weapons:

Units who capture or find suspected chemical and/or biological munitions or material will not handle, move, or destroy them. Units will mark the location and, if possible, secure the area and identify the location to XVIII Corps G3 operations and supporting EOD teams. Iraqi chemical munitions may be difficult to identify. Some are possibly marked with gold, yellow, green, or blue bands. Other marking schemes and/or patterns may exist. CW/BW munitions may be stored with conventional munitions....Units are currently not authorized to destroy chemical/biological munitions. EOD will have technical responsibility for control and disposition of chemical/biological munitions. Under no circumstances will chemical/biological weapons be retrograded out of Kuwait or Iraq into Saudi Arabia without COMARCENT approval.<sup>13</sup>

On February 27, 1991, at 1330 hours local time, the 2-69<sup>th</sup> Armor Battalion, 197<sup>th</sup> Infantry Brigade, 24<sup>th</sup> Mechanized Infantry Division conducted a raid on Tallil Air Base. This was the first time in the Gulf War that US ground forces had entered this facility.<sup>14</sup> This action was a tactical feint designed to convince Iraq's senior leadership that the 24<sup>th</sup> Mechanized Infantry Division intended to continue its drive north and cross the Euphrates river—when in fact, the 24<sup>th</sup> would proceed to the south and take the regional city of Basra. This raiding force did not occupy or clear Tallil. According to the Commander of the 2-69<sup>th</sup>, his tanks only penetrated 600-700 yards into the base and stayed about 45-60 minutes. The 2-69<sup>th</sup> did not search or clear any bunkers during this action.<sup>15</sup> The raid was short, but intense, destroying 6 fighter-attack aircraft,

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<sup>12</sup> DIA, Subject: Response to RII-2093, February 7, 1991.

<sup>13</sup> ARCENT Daily Staff Journal or Duty Officers Log, Subject: Captured Chemical and Biological Munitions, February 27, 1991.

<sup>14</sup> 197<sup>th</sup> Infantry Brigade Desert Shield/Storm History, p.8.

<sup>15</sup> Interview with 2-69<sup>th</sup> Commander, May 19, 1997.



3 helicopters, 4 self-propelled anti-aircraft artillery pieces, and 2 tanks.<sup>16</sup> While the 2-69<sup>th</sup> suffered no casualties, it did leave behind four vehicles immobilized by mechanical and terrain difficulties. The 2-69<sup>th</sup> then refueled south of Tallil at 1730 hours in order to rejoin the 24<sup>th</sup> Mechanized Infantry Division's drive toward Basra.<sup>17</sup>

### **The Cease-Fire and Occupation of Tallil**

After the cease-fire went into effect during the morning hours of February 28, 1991, a psychological operations plan was developed by units of the 82<sup>nd</sup> Airborne Division to convince the Iraqi soldiers still occupying Tallil to vacate the area to the northwest or surrender without resistance.<sup>18</sup> The plan worked. On March 1 and 2, 1991, units of the 82<sup>nd</sup> Airborne took control of the base without major incident. Units of the 82<sup>nd</sup>—including the 504<sup>th</sup> and 505<sup>th</sup> Parachute Infantry Regiments and other subordinate units (see TAB B)—occupied the base and started the long process of identifying munitions and other materiel to be destroyed before the departure of US forces. While many small infantry units performed impromptu demolition of fighting trenches, personnel bunkers, arms caches, and vehicles, most of the systematic demolition of large quantities of munitions and major facilities was performed by C Company, 307<sup>th</sup> Engineering Battalion, with the technical advice and support of the 60<sup>th</sup> Explosive Ordnance Disposal (EOD) Detachment. When the 82<sup>nd</sup> units rotated out of the area on approximately March 24, 1991, they were replaced by the 2<sup>nd</sup> Armored Cavalry Regiment and the 84<sup>th</sup> Engineering Company.<sup>19</sup>

Many of the facilities at Tallil, especially hardened aircraft shelters, had already been hit by Precision Guided Munitions (see Tallil photos, Tab E). Some of these attacks destroyed the facilities and their contents in place, while others initiated secondary explosions, scattering material and debris for considerable distances. Large areas of the base had also been seeded with US aerial mines (nicknamed 'gators') to impede movement of aircraft and vehicles on the airfield's parking aprons, taxiways, and runways. One of the highest priorities of local US commanders was to identify hazardous areas: the two primary concerns were potential chemical weapons (CW) sites and unexploded ordnance. CW personnel from the 82<sup>nd</sup> Airborne Division conducted CW search operations with a full range of CW detection equipment (including two Fox reconnaissance vehicles), while the 60<sup>th</sup> EOD identified and neutralized most of the US and Iraqi unexploded ordnance.<sup>20</sup>

### **Search for Chemical Weapons**

A March 23, 1991, message from the 82nd Airborne Division chemical officer to the 2nd Armored Cavalry Regiment chemical officer summarizes the search for chemical weapons at Tallil:

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<sup>16</sup> 197<sup>th</sup> Infantry Brigade Desert Shield/Storm History, p. 14.

<sup>17</sup> 197<sup>th</sup> Infantry Brigade Desert Shield/Storm History, p. 8.

<sup>18</sup> Document, 505<sup>th</sup> Parachute Infantry Regimental History, Operation Desert Shield/Storm, p. K-5.

<sup>19</sup> Document, 505<sup>th</sup> Parachute Infantry Regimental History, Operation Desert Shield/Storm.

<sup>20</sup> 60<sup>th</sup> EOD Incident Journal, Desert Storm.

When the 82<sup>nd</sup> occupied the sector, Fox vehicles and unit reconnaissance teams checked for CW and CW contamination, but found none.<sup>21</sup> They checked the air base and marked the buildings with spray paint during the clearing process. They marked several buildings "chem," but these contained NBC protective equipment (gas masks, filters, suits, antidotes, etc.), decontaminates, or industrial chemicals—not chemical weapons.<sup>22</sup>

Interviews with a Brigade-level chemical officer of the 82<sup>nd</sup> and a Fox vehicle crew member operating at Tallil confirmed this message summary. Because the Fox vehicle was too big to enter the bunkers, the search teams used hand-held testing systems—including the M256 Chemical Agent Detection Kit and Chemical Agent Monitors—to check the bunker interiors, but they found no chemical weapons or agents.<sup>23</sup>

A member of the US Army's 60<sup>th</sup> EOD searched the S-shaped bunker that might have contained chemical weapons. For safety reasons, it was standard procedure for EOD personnel to clear facilities before other personnel entered, so it is likely that he was the first person to enter this bunker. A bomb had partially collapsed the roof into the main storage area and numerous anti-personnel and anti-vehicle mines were scattered through this area,<sup>24</sup> so it is unlikely that other non-EOD individuals would have entered this bunker for 'sightseeing' purposes.

To penetrate reinforced concrete bunkers, the US Air Force uses a laser guided, 2,000-pound general purpose bomb known as the BLU-109.<sup>25</sup> This weapon's hardened steel casing allows it to penetrate several feet of earthen cover and reinforced concrete before detonating. When detonation occurs within a confined space, like a reinforced concrete bunker, the blast and a portion of the bunker's contents are blown through the doors, ventilation ducts, and the bomb's entry hole. If the contents are flammable or explosive, a secondary explosion usually results, which in most cases will completely destroy the bunker and its contents. If the bunker contains nothing flammable or explosive, the structure will often survive partially or even completely intact structurally, even though some of its contents may have been severely damaged or destroyed. Depending on the type and quantity of items stored in a bunker, the size of the bunker, and the entry angle and fusing of the weapon, it is possible for some of a bunker's contents to survive the penetration and detonation of a BLU-109.

Of the more than 100 veterans interviewed during this investigation who had conducted significant operations (i.e., searched bunkers or conducted demolition operations) at Tallil, only

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<sup>21</sup> Message, Commander 82<sup>nd</sup> Airborne Division, No Subject Given, March 23, 1991.

<sup>22</sup> Message, Commander 82<sup>nd</sup> Airborne Division, No Subject Given, March 23, 1991.

<sup>23</sup> Interviews with 82<sup>nd</sup> Airborne Division Chemical Officer, CMAT number: 1997109-024 and Interview Notes, June 17, 1996. Interview with 82<sup>nd</sup> Airborne Brigade level Chemical Officer is documented in Transcript of Proceedings, Interviews Concerning Activities at Khamisiyah, Iraq in March 1991, CMAT number 1997143-0000062, p. 9-29. Interview with Fox vehicle operator is documented in Callback Summary, CMAT number 1997013-053, May 15, 1997.

<sup>24</sup> Transcript of Interview with 60<sup>th</sup> EOD technician, April 10, 1997, Interview with USAF 4404<sup>th</sup> EOD member on October 13, 1997, CMAT number: 1997286-0000012, and DIA, Subject: Inspection of the S-shaped Bunker, May 28, 1993.

<sup>25</sup> Gulf Air War Debrief, Aerospace Publishing, London, 1991, p. 214-215.

two EOD technicians (one US Army, one US Air Force) were located who could identify the location of the S-shaped bunker, its external characteristics, and internal contents. The 60<sup>th</sup> EOD technician who searched the S-shaped bunker did not report seeing any items that resembled either conventional or chemical munitions. He found only debris and rubble, and scorching from the BLU-109 detonation. He found no evidence of a secondary explosion, which there probably would have been if the bunker had been used to store conventional munitions. He also saw no evidence that material of any kind was stored in the bunker at the time it was struck, although it is possible that material could have been buried under the partially collapsed ceiling.<sup>26</sup> The only other member of the 60<sup>th</sup> EOD team at Tallil did not enter this bunker, so he could not confirm the report of the contents of the bunker, but he reported that he did not see any CW during his work on this installation.<sup>27</sup> The 60<sup>th</sup> EOD incident journal confirms the statements of these technicians; it does not list any CW being found at Tallil.<sup>28</sup>

The USAF EOD technician who entered the S-shaped bunker also found no evidence of CW. He described the bunker as being seriously damaged with large chunks of concrete present and the roof collapsed. He reported seeing no CW in the bunker's exposed area, nor did he report seeing either CW residue or liquids. This technician also checked other Tallil storage bunkers without finding any chemical weapons, but did remember seeing CW-associated equipment such as protective equipment and antidote kits in bulk quantities, which were present in most of the bunkers he inspected.<sup>29</sup>

### **Demolition Activities**

The Combat Engineers who assisted the 60<sup>th</sup> EOD in destroying facilities and munitions were primarily from B and C Companies, 307<sup>th</sup> Engineering Battalion, with the former having a limited role because of other duties. More than 25 engineers from C Company have been interviewed, including platoon leaders, the executive officer, and the 307<sup>th</sup> Engineering Battalion Commander. Destroying captured munitions is not normally part of the Combat Engineer Military Occupational Specialty (MOS), but because of the large quantities at Tallil, EOD personnel gave the Engineers on-the-job training and put them to work rigging explosives. During interviews with C Company Engineers, they consistently reported that they rigged no CW munitions and had no first-hand knowledge of CW being discovered at Tallil.<sup>30</sup> The Commander of the 307<sup>th</sup> Engineering Battalion was physically present at Tallil from approximately March 3-10, 1991. The day before his arrival, he remembers receiving a division intelligence report of a probable chemical facility at Tallil. He remembers receiving no other specific CW warnings. He and his subordinates did not wear CW protective gear while at Tallil

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<sup>26</sup> Transcript of Interview with 60<sup>th</sup> EOD technician, April 10, 1997, p. 5-11.

<sup>27</sup> Interview with senior 60<sup>th</sup> EOD technician May 23, 1997, CMAT number: 1997140-0000115.

<sup>28</sup> 60<sup>th</sup> EOD Incident Journal; Desert Storm. This journal references the discovery of a single suspected chemical shell at coordinates several kilometers east of the An Nasiriyah SW ASP on March 7<sup>th</sup>, 1991. As indicated in the journal entry, Fox vehicles detected no chemical agents in the munitions or in the area at the coordinates given.

<sup>29</sup> Interview with USAF 4404<sup>th</sup> EOD member on October 13, 1997, CMAT number: 1997286-0000012.

<sup>30</sup> Interviews with C Company, 307<sup>th</sup> Engineering Battalion, 1<sup>st</sup> platoon leader, October 23, 1996, CMAT number: 1997162-0000175; 2<sup>nd</sup> platoon leader, April 29, 1997, CMAT number: 1997113-0000145; 3<sup>rd</sup> platoon leader, CMAT number 199710930; and Battalion XO, October 23, 1996, CMAT number: 1997162-0000168.

since the facility had already been cleared by 82<sup>nd</sup> CW personnel.<sup>31</sup> The Engineer and EOD teams destroyed army conventional munitions like small arms ammunition, mortar rounds, anti-tank rockets, artillery rockets, artillery rounds, anti-aircraft artillery rounds, tank ammunition, and explosives.<sup>32</sup> They also destroyed aircraft munitions like general purpose bombs, cluster munitions, incendiary bombs, unguided rockets, air-to-air, and air-to-ground missiles.<sup>33</sup> A 307<sup>th</sup> Engineering Battalion operations summary reported that they also destroyed 18 MiG aircraft. No CW items were listed.<sup>34</sup>

While the 307<sup>th</sup> Engineers and the 60<sup>th</sup> EOD performed the majority of bunker demolition work at Tallil, several other units were also involved. USAF Red Horse civil engineering teams used approximately 80,000 pounds of explosives to make cuts in the runways and taxiways every 2,000 feet.<sup>35</sup> USAF EOD technicians from the 1703<sup>rd</sup> and 4404<sup>th</sup> EOD Detachments were also there. In addition to destroying unexploded ordnance, they identified specific air-to-air and air-to-ground ordnance for shipment to rear areas. Investigators interviewed several of these individuals, including the 1703<sup>rd</sup> EOD commander; none of them saw any chemical weapons.<sup>36</sup> Organized demolition operations by units of the 82<sup>nd</sup> Airborne began on March 2, 1991, and continued through approximately March 23, 1991.

On approximately March 24, 1991, units of the 82<sup>nd</sup> Airborne (including the 307<sup>th</sup> Engineering Battalion and the 60<sup>th</sup> EOD Detachment) rotated out of the area and were replaced by the 2<sup>nd</sup> Armored Cavalry Regiment and its supporting units, which included the 84<sup>th</sup> Engineering Company and the 146<sup>th</sup> EOD Detachment.<sup>37</sup> The logs of the 146<sup>th</sup> indicate that the new units continued to destroy substantial quantities of munitions and that demolition operations at Tallil and the nearby An Nasiriyah SW Ammunition Storage Point (ASP) continued into April 1991.<sup>38</sup> In an interview with the commander of the 146<sup>th</sup> EOD, he stated that he supervised the destruction of large quantities of army and air force ordnance, bunkers, aircraft, and facilities, but he did not observe any CW.<sup>39</sup> The Tallil S-shaped bunker that was successfully attacked during the air war was not further demolished.<sup>40</sup>

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<sup>31</sup> Interview with 307<sup>th</sup> Engineering Battalion Commander, May 7, 1997.

<sup>32</sup> 60<sup>th</sup> EOD Incident Journal, Desert Storm, and 146<sup>th</sup> EOD Incident Journal, Desert Shield/Storm, May 15, 1991.

<sup>33</sup> 60<sup>th</sup> EOD Incident Journal, Desert Storm, and 146<sup>th</sup> EOD Incident Journal, Desert Shield/Storm, May 15, 1991.

<sup>34</sup> Message, 307<sup>th</sup> Engineering Battalion Operations Summary, March 23, 1991, p. 1-5. Note: this summary does not include aircraft destroyed by US Air Force munitions nor aircraft destroyed by other units.

<sup>35</sup> Document, Engineering and Services in the Gulf War.

<sup>36</sup> Interviews with 1703<sup>rd</sup> EOD members: May 27, 1997, CMAT number: 1997121-0000012, May 6, 1997, CMAT number: 1997118-0000043; March 3, 1997, CMAT number: 1997063-004; May 29, 1997, CMAT number: 1997141-0000081; May 14, 1997, CMAT number 1997121-0000014.

<sup>37</sup> Message, Commander 82<sup>nd</sup> Airborne Division, No Subject Given, March 23, 1991 and Interviews with 82<sup>nd</sup> Airborne Division Chemical Officer, CMAT number: 1997109-024.

<sup>38</sup> 146<sup>th</sup> EOD Incident Journal, Desert Shield/Storm, May 15, 1991. The investigation of the An Nasiriyah SW ASP by the Office of the Special Assistant for Gulf War Illness (OSAGWI) is continuing as a separate case and a narrative on it will be published in the future.

<sup>39</sup> Interview with 146<sup>th</sup> EOD Commander, June 3, 1997, CMAT number 1997112-0000040, lead sheet 895.

<sup>40</sup> Transcript of Interview with 60<sup>th</sup> EOD technician, April 10, 1997, p. 5-11, Interview with USAF 4404<sup>th</sup> EOD member on October 13, 1997, CMAT number: 1997286-0000012, and DIA, Subject: Inspection of the S-shaped Bunker, May 28, 1993.

None of the individuals interviewed in this investigation reported experiencing medical symptoms associated with nerve or blister agent poisoning, nor did they seek medical attention because of contact with a suspected chemical warfare agent during demolition operations at Tallil. While several individuals interviewed reported that they encountered possible CW,<sup>41</sup> their visual identifications were based on observed munitions color schemes like yellow or red bands, which were not reliable indicators of CW. None of these individuals reported experiencing any chemical agent symptoms after being in the vicinity of, or in contact with, munitions with these markings. One individual from the 505<sup>th</sup> Parachute Infantry Regiment reported in an interview that he became very nauseous and dizzy after being exposed to a white powder in a can while removing equipment and weapons from a Tallil warehouse. The inhaled substance caused him to vomit immediately, but the nausea only lasted one to three hours and was not severe. He did not report this incident or seek medical attention at the time it occurred, and he did not report any lasting effects from this incident.<sup>42</sup> The unidentified powder could have been a number of different compounds, including a riot control agent, but the specific circumstances related during the interview make a follow-up determination impossible. At any rate, these symptoms are not indicative of exposure to any of the chemical warfare agents assessed to be in Iraq's inventory.

### **Activity after US Occupation**

Approximately 18 months passed between the withdrawal of US forces from the Tallil area and the inspection of the Tallil S-shaped bunker by United Nations (UN) CW technical experts. During this period, Iraq attempted to salvage material, equipment, and facilities at Tallil for further use by the Iraqi military. On December 8, 1992, a UN Special Commission (UNSCOM) chemical and biological weapons inspection team inspected Tallil airfield. The team found nothing there relating to UN Security Council Resolution 687 (which addresses "weapons of mass destruction"—including chemical weapons).<sup>43</sup> At the S-shaped bunker, they saw the heavy bomb damage from Desert Storm. Although the center roof section was collapsed, the side panel roof sections were intact, leaving room to maneuver within the bunker on either side of the collapsed center section.<sup>44</sup> The interior contents were described in the report as follows:

The bunker contained at least 30 crated FAB-500 high explosive (HE) aerial bombs as well as at least 8 gray packing crates (1x1.5 meters). No vehicular access through the bunker was possible, since the bomb/crate storage blocked the thoroughfare. One crate was split open, and paper wrapping was noted at one corner; the contents were not observed. Markings were noted on the side.

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<sup>41</sup> Examples of Engineers who reported that they saw CW (based on color bands) include CMAT 1997162-0000837 and 1997162-0000255. The first reported that he destroyed six gray bombs with red and yellow strips painted on them, the second that 5 or 10 percent of the artillery shells he observed in bunkers had white or yellow markings on the nose of the projectiles. EOD interview CMAT #1997121-0000012 specifically mentioned finding gray munitions with red bands - and they were not CW. EOD interview CMAT #1997140-0000115 mentioned that CW could be recognized by filler plugs, color (two yellow bands), double walled construction, and thin skin. He also stated that it was taken for granted that CW may not be marked or marked inconsistently, making marking schemes an unreliable indicator of CW.

<sup>42</sup> 505<sup>th</sup> PIR interview CMAT #1997175-0000203.

<sup>43</sup> DIA, Subject: Inspection of the S-shaped Bunker, May 28, 1993.

<sup>44</sup> DIA, Subject: Inspection of the S-shaped Bunker, May 28, 1993.

Numerous copies of shipping documents were scattered on the floor. Yellow "end labels" for crates for FAB-500 and FAB-250 bombs were also found. A hand-written note in Arabic described the symptoms for nerve agent poisoning. Comments: The S-shaped bunker is designed for special weapon storage; however, no typical western method for chemical agent/weapon storage was noted outside of the sump. Iraq did not conform to western methods at its Samarra chemical weapon cruciform bunkers. Since the bunker was available for storage, the Iraqis probably placed FAB-500/250 HE aerial bombs in it for storage and would have probably removed them if special weapons were brought there.<sup>45</sup>

On July 29, 1997, in Buffalo, NY, two representatives of UNSCOM testified about Tallil's S-shaped bunker at a hearing of the Presidential Advisory Committee for Gulf War Veteran's Illnesses. They reported that they believed that Iraq deployed chemical weapons in January 1991, only to four depots (none of which was Tallil) and back to areas near Baghdad.<sup>46</sup> In response to a later question, they clarified that nothing was found at Tallil:

MR. MITROKHIN (UNSCOM): ... UNSCOM inspected, of course, Nasiriyah munitions depot, Khamisiyah ammunition depot, Tallil Air Field in 1992 and also underground storage bunkers which is entry number 12 on your list. This was inspected in 1994. The results of following inspections at Nasiriyah and Khamisiyah ammunition depots are well-known and we briefed the committee on these results. Concerning Tallil Air Field and underground storage bunkers which appeared to be the stores of metal missiles were inspected and no evidence of chemical weapons found there.

DR. PORTER (PAC): Let, let me understand. There were four sites of the 17 that UNSCOM visited.

MR. MITROKHIN (UNSCOM): That is correct.

DR. PORTER (PAC): And of course one was Khamisiyah, we know the Khamisiyah story, but at the other three sites, the inspection revealed no evidence of chemical weapons or damage.

MR. MITROKHIN (UNSCOM): Actually, yes. As it was explained by Mr. Duelfer, 155 mm. shells were removed from Nasiriyah ammunition depot prior to UNSCOM arrival and later on these were found in the vicinity of the Khamisiyah ammunition depot in the desert area. Concerning two remaining sites, Tallil Air Field and underground storage bunkers, no evidence of chemical weapons were found there.<sup>47</sup>

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<sup>45</sup> DIA, Subject: Inspection of the S-shaped Bunker, May 28, 1993.

<sup>46</sup> Testimony at the Presidential Advisory Committee on Gulf War Veteran's Illnesses public hearing, Buffalo, NY, July 29, 1997 by Charles Duelfer and Igor A. Mitrokhin, United Nations Special Commission on Iraq.

<sup>47</sup> Testimony at the Presidential Advisory Committee on Gulf War Veteran's Illnesses public hearing, Buffalo, NY, July 29, 1997 by Charles Duelfer and Igor A. Mitrokhin, United Nations Special Commission on Iraq.

After the departure of US forces from Iraq, this UN inspection is the only known on-site examination of the internal condition and contents of Tallil's S-shaped bunker.

In 1996, Iraq presented to UNSCOM a document known as the Full, Final, and Complete Disclosure on their CW program.<sup>48</sup> This document listed the specific types of CW in the Iraqi inventory and their location during the 1991 time period. Tallil Air Base is not listed in this document as a CW storage site.

## ASSESSMENT

Although the Iraqis flew chemical warfare missions out of Tallil air base during the Iran-Iraq War—and probably stored chemical weapons for these missions in the base's S-shaped bunker—occupying forces at the conclusion of the Gulf War found no chemical weapons or chemical agent contamination there. Due to pre-war briefings that Iraqi CW were painted certain colors or marked with color bands, some interviewed individuals believed that they had discovered, reported, or destroyed Iraqi CW. However, post-war assessments of Iraq's CW program confirmed that this identification method was totally unreliable. Instead, interviews with EOD personnel indicated that they relied on specific munitions design characteristics to identify CW, but that no system by itself was considered 100 percent accurate. Hence, the use of multiple methods to identify and/or confirm the presence of CW.

Chemical weapons (CW) specialists used various chemical detection equipment at Tallil Air Base and found nothing. EOD personnel and others with direct knowledge of CW characteristics saw nothing to indicate the presence of CW. Demolition crews that destroyed munitions, equipment, and structures at the base also discovered no chemical weapons. However, their extensive searches did turn up significant quantities of CW-associated defensive gear like masks, suits, antidotes, and decontaminates, but this was expected based on Tallil's history during the Iran-Iraq war. These first-hand observations, the reconnaissance of the area by chemical personnel, and intelligence reporting indicate that it is unlikely that either chemical warfare agents or chemical weapons were stored in the S-shaped bunker or on the base at the time of the US occupation.

The UNSCOM team that inspected Tallil and its S-shaped bunker in December 1992 did not find evidence of chemical weapons or bulk agents. However, it is important to note that neither the US occupation forces nor the UNSCOM team were able to inspect the portion of the S-shaped bunker where the ceiling had collapsed. Nor could they examine any materials buried under the remaining debris. After the war, the Iraqis cleared the intact area of the bunker of rubble and

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<sup>48</sup> DOD, Subject: Iraqi Fallujah, Khamisiyah, and An Nasiriyah Chemical Warfare related sites, May 1996. There was one CW storage site listed that was close to Tallil. The An Nasiriyah SW ASP received approximately 6,240 155mm mustard (HD) artillery shells in the time period of January 10-15, 1991. These shells were later transferred during mid-February, 1991 to a depression located approximately 5 km to the west of Khamisiyah where they remained undisturbed until after US forces departed the area. Although approximately 22 bunkers in this ASP were struck by aerial munitions during the January 17 to February 28, 1991, air campaign, these munitions were stored in a bunker that was not struck by coalition air ordnance.

used it for conventional munitions storage. If the Iraqis were storing chemical weapons or agents in this facility at the time it was struck during the war, the resulting contamination would almost certainly have forced the Iraqis to completely remove all bunker debris, extensively decontaminate the area, and then rebuild before using the bunker for conventional storage. This was not done. In addition, Tallil was not listed as a CW storage site in the Full, Final, and Complete Disclosure provided to the UNSCOM in 1996. Based on these facts and the lack of any US reports of chemical warfare agent detections or chemical warfare agent injuries, our assessment is that it is unlikely that chemical weapons or agents were present at Tallil Air Base during the period of US occupation in 1991.

***This case is still being investigated. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DOD Persian Gulf Task Force Hot Line at***

***1-800-472-6719.***



## ***TAB A - Acronym Listing/Glossary***

### **Acronyms**

ASP .....	Ammunition Storage Point
BLU-109A .....	2,000lb hard target penetration weapon
BW .....	Biological Weapon
COMARCENT .....	Commander, Army Component, Central Command
CS .....	Riot Gas (i.e., tear gas)
CW .....	Chemical Weapon
DOD .....	Department of Defense
EOD .....	Explosive Ordnance Disposal
FAB-500/250 .....	A type of Russian 500 or 250 kg HE bomb
GA .....	Tabun nerve agent
GB .....	Sarin nerve agent
HE .....	High Explosive
KTO .....	Kuwait Theater of Operations
Mk-82/83/84 .....	A family of 500lb, 1,000lb, and 2,000lb general purpose bombs
MOS .....	Military Occupational Specialty
Mustard .....	A Chemical Blister Agent
OSAGWI .....	Office of the Special Assistant for Gulf War Illnesses
UN .....	United Nations
UNSCOM .....	United Nations Special Commission
USAF .....	US Air Force
VX .....	A type of nerve agent

### **Glossary**

**Detection Paper:** Detection paper is based on certain dyes being soluble in chemical warfare agents. Normally, two dyes and one pH indicator are used, which are mixed with cellulose fibers in a paper without special coloring (unbleached). When a drop of chemical warfare agent is absorbed by the paper, it dissolves one of the pigments. Mustard agent dissolves a red dye and nerve agent a yellow. In addition, VX causes the indicator to turn to blue which, together with the yellow, will become green/green-black.

Detection paper can thus be used to distinguish between three different types of chemical warfare agents. A disadvantage with the papers is that many other substances can also dissolve the pigments. Consequently, they should not be located in places where drops of solvent, fat, oil or fuel can fall on them. Drops of water do not trigger a reaction.

On the basis of spot diameter and density on the detection paper, it is possible to obtain an opinion on the original size of the droplets and the degree of contamination. A droplet of 0.5 mm diameter gives a spot sized about 3 mm on the paper. A droplet/cm<sup>2</sup> of this kind corresponds

to a ground contamination of about 0.5 g/m<sup>2</sup>. The lower detection limit in favorable cases is 0.005 g/m<sup>2</sup>.

*Reference: Detection of Chemical Weapons: An overview of methods for the detection of chemical warfare agents*

**M256A1 Chemical Agent Detection Kit:** The M256A1 kit is a portable, expendable item capable of detecting and identifying hazardous concentrations of chemical agent. The M256 kit is used after a chemical attack to determine if it is safe to unmask. The M256A1 kit has replaced the M256 kit. The only difference between the two kits is that the M256A1 kit will detect lower levels of nerve agent. This improvement was accomplished by using an eel enzyme for the nerve test in the M256A1 kit in place of the horse enzyme used in the M256 kit.

*Reference: Worldwide Chemical Detection Equipment Handbook, p. 430.*

**M8A1 Chemical Alarm:** The M8A1 is an automatic chemical agent detection and warning system designed to detect the presence of nerve agent vapors or inhalable aerosols. The M8A1 will automatically signal the presence of the nerve agent in the air by providing troops with both a audible and visible warning. The M8A1 was fielded to replace the wet chemical M8 detector with a dry system—which eliminated the M229 refill kit, the logistic burden, and associated costs. The M8A1 operates in a fixed, portable, or vehicle mounted configuration.

*Reference: Worldwide Chemical Detection Equipment Handbook, p. 412*

**Mustard:** Mustard "gas" refers to several manufactured chemicals including sulfur mustard. They do not occur naturally in the environment. The term gas is in quotes because mustard "gas" does not behave as a gas under ordinary conditions. Mustard "gas" is really a liquid and is not likely to change into a gas immediately if it is released at ordinary temperatures. As a pure liquid, it is colorless and odorless, but when mixed with other chemicals, it looks brown and has a garlic-like smell. Mustard "gas" was used in chemical warfare and was made in large amounts during World Wars I and II. It was reportedly used in the Iran-Iraq war in 1984-1988. It is not presently used in the United States, except for research purposes. The only way that mustard "gas" could enter the environment [other than through use as a weapon] would be through an accidental release. Some evaporates from water and soil into the air. It does not easily dissolve in water, and the amount that does, breaks down quickly. It is more stable in soil than in water, but still breaks down within days, depending on the outside temperature (cold weather makes it more stable). It does not go from soil to groundwater. Mustard "gas" does not build up in animal tissue because it breaks down so quickly. Mustard "gas" makes your eyes burn, your eyelids swell, and causes you to blink a lot. If you breathe mustard "gas," it can cause coughing, bronchitis, and long-term respiratory disease.

*References: Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for mustard "gas." Atlanta, GA: US Department of Health and Human Services, Public Health Service.*

**Sarin:** Sarin is a light brown liquid. It is odorless, and evaporates about as fast as gasoline. It is toxic both as fumes and to the touch. It is not as persistent an agent as Tabun or Soman, the other two of the trinity of nerve gases developed in Germany.

Sarin, along with Tabun and Soman, was invented not long before the Second World War by German scientist Dr. Gerhard Schrader. While developing insecticides similar to malathion and parathion, he discovered the first "nerve gas" agents. In 1936, he discovered Sarin. The Germans stockpiled these weapons during the Second World War, but never used them, probably because of Hitler's personal distaste for the weapons (he himself was a victim of gas attacks in Flanders during the First World War). Sarin is now known as "GB." Only very small amounts of Sarin, a single milligram coming in contact with the skin, is sufficient to kill. In a vaporous form, it takes a concentration of 100 milligrams per cubic meter to be fatal.

Nerve gases such as Sarin are known as "organophosphorus anticholinesterases" or "OP's." Their chemical method of killing is to block the enzyme cholinesterase. The body's muscles receive electrical impulses caused by choline. Cholinesterase break down choline, making sure these impulses stop at the proper time. Cholinesterase attaches itself to choline and breaks it down, thus halting the impulse. Sarin fools the cholinesterase into acting upon the Sarin as it would choline. When the cholinesterase attaches itself to Sarin, it doesn't break down. Thus, choline is not broken down, and the body goes into convulsions. The first symptoms start in the eyes, where the pupils contract and vision is blurred. It causes breathing problems and chest tightness. Finally it produces vomiting and headaches, after which the heart and lungs stop as the body convulses. The antidote is a substitute for the missing cholinesterase, which is atropine. The armed forces in the Gulf War were given Oxime tablets in case of gas attack, which acts to release cholinesterase from the Sarin.

*References: Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Toxicological profile for Sarin. Atlanta, GA: US Department of Health and Human Services, Public Health Service.*

**UN Security Council Resolution 687:** This resolution was adopted by the UN Security Council at its 2981st meeting, on April 3, 1991. The pertinent section of this resolution, as it relates to the Tallil narrative, follows:

6. Notes that as soon as the Secretary-General notifies the Security Council of the completion of the deployment of the United Nations observer unit, the conditions will be established for the Member States cooperating with Kuwait in accordance with resolution 678 (1990) to bring their military presence in Iraq to an end consistent with resolution 686 (1991);

Invites Iraq to reaffirm unconditionally its obligations under the Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and to ratify the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, of 10 April 1972;

Decides that Iraq shall unconditionally accept the destruction, removal, or rendering harmless, under international supervision, of:

(a) All chemical and biological weapons and all stocks of agents and all related subsystems and components and all research, development, support and manufacturing facilities;

(b) All ballistic missiles with a range greater than 150 kilometers and related major parts, and repair and production facilities; Decides, for the implementation of paragraph 8 above [paragraph 6 is only numbered paragraph in document], the following:

(a) Iraq shall submit to the Secretary-General, within fifteen days of the adoption of the present resolution, a declaration of the locations, amounts and types of all items specified in paragraph 8 and agree to urgent, on-site inspection as specified below;

(b) The Secretary-General, in consultation with the appropriate Governments and, where appropriate, with the Director-General of the World Health Organization, within forty-five days of the passage of the present resolution, shall develop, and submit to the Council for approval, a plan calling for the completion of the following acts within forty-five days of such approval.

*Reference: UN Security Council Resolution 687, dated April 1991.*

## ***TAB B - Units Involved<sup>49</sup>***

1<sup>st</sup> Brigade, 82<sup>nd</sup> Airborne Division (also known as the 504<sup>th</sup> Parachute Infantry Regiment)

1-1<sup>st</sup> Aviation Battalion, 1<sup>st</sup> Infantry Division Aviation Brigade, 1<sup>st</sup> Infantry Division

2<sup>nd</sup> Armored Cavalry Regiment

3<sup>rd</sup> Brigade, 82<sup>nd</sup> Airborne Division (also known as the 505<sup>th</sup> Parachute Infantry Regiment)

Headquarters and Headquarters Company, 12<sup>th</sup> Aviation Brigade

1-17<sup>th</sup> Cavalry, 82<sup>nd</sup> Airborne Division Aviation Brigade

18<sup>th</sup> Infantry Battalion, 197<sup>th</sup> Infantry Brigade, 24<sup>th</sup> Infantry Division

21<sup>st</sup> Chemical Company, 82<sup>nd</sup> Airborne Division

24<sup>th</sup> Signal Battalion, 24<sup>th</sup> Infantry Division

36<sup>th</sup> Medical Detachment (Helicopter Ambulance), 1<sup>st</sup> Medical Group, 44<sup>th</sup> Medical Brigade

60<sup>th</sup> Explosive Ordnance Disposal Detachment (US Army)

2-69<sup>th</sup> Armor Battalion, 197<sup>th</sup> Infantry Brigade, 24<sup>th</sup> Infantry Division

3-73<sup>rd</sup> Armored Battalion, 82<sup>nd</sup> Airborne Division

82<sup>nd</sup> Engineer Company, 2<sup>nd</sup> ACR

84<sup>th</sup> Engineer Company, 2<sup>nd</sup> ACR

87<sup>th</sup> Chemical Company, 2<sup>nd</sup> ACR

146<sup>th</sup> Explosive Ordnance Disposal Detachment (US Army)

6-158<sup>th</sup> Aviation Battalion, 12<sup>th</sup> Aviation Brigade

307<sup>th</sup> Engineer Battalion, 82<sup>nd</sup> Airborne Division

307<sup>th</sup> Medical Battalion, 82<sup>nd</sup> Airborne Division

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<sup>49</sup> Entire units or only some individuals from the unit may have been in the vicinity of Tallil.

313<sup>th</sup> Military Intelligence Battalion, 82<sup>nd</sup> Airborne Division

1-319<sup>th</sup> Field Artillery Battalion, 82<sup>nd</sup> Airborne Division

407<sup>th</sup> Supply and Transportation Battalion, 82<sup>nd</sup> Airborne Division

450<sup>th</sup> Civil Affairs Company, 360<sup>th</sup> Civil Affairs Brigade

497<sup>th</sup> Transportation Company, 46<sup>th</sup> Corps Support Group, 1<sup>st</sup> Corps Support Command

504<sup>th</sup> Parachute Infantry Regiment (also known as the 1<sup>st</sup> Brigade, 82<sup>nd</sup> Airborne Division)

505<sup>th</sup> Parachute Infantry Regiment (also known as the 3<sup>rd</sup> Brigade, 82<sup>nd</sup> Airborne Division)

533<sup>rd</sup> Transportation Company, 46<sup>th</sup> Corps Support Group, 1<sup>st</sup> Corps Support Command

546<sup>th</sup> Transportation Company, 46<sup>th</sup> Corps Support Group, 1<sup>st</sup> Corps Support Command

603<sup>rd</sup> Transportation Company, 46<sup>th</sup> Corps Support Group, 1<sup>st</sup> Corps Support Command

782<sup>nd</sup> Maintenance Battalion, 82<sup>nd</sup> Airborne Division

1703<sup>rd</sup> EOD (US Air Force)

4404<sup>th</sup> EOD (US Air Force)

## ***TAB C - Bibliography***

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505<sup>th</sup> Parachute Infantry Regimental History, Operation Desert Shield/Storm.

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Interview with 2-69<sup>th</sup> Armor Battalion Commander, 19 May 97.

Interview with 82<sup>nd</sup> Airborne Division Chemical Officer, CMAT number: 1997109-024 and Interview Notes, June 17, 1996.

Interview with 82<sup>nd</sup> Airborne Brigade level Chemical Officer, Transcript of Proceedings, Interviews Concerning Activities at Khamisiyah, Iraq in March 1991, CMAT number 1997143-0000062, p. 9-29.

Interview with Fox vehicle operator, CMAT number 1997013-053, May 15, 1997.

Interview with 60<sup>th</sup> EOD technician, May 23, 1997, CMAT number: 1997140-0000115.

Interview with senior 60<sup>th</sup> EOD technician, April 10, 1997, Khamisiyah Team Visit to Eglin AFB, FL.

Interview with 146<sup>th</sup> EOD Commander, June 3, 1997, CMAT number 1997112-0000040.

Interviews with C Company, 307<sup>th</sup> Engineering Battalion, 1<sup>st</sup> platoon leader, October 23, 1996, file number: 95303-CW-UNSC-I-0061; 2<sup>nd</sup> platoon leader, April 29, 1997, CMAT number: 1997113-0000145; 3<sup>rd</sup> platoon leader, CMAT number 1997109-30; and Battalion Executive Officer, October 23, 1996, file 95303-CW-I-0061.

Interview with 307<sup>th</sup> Engineering Battalion Commander, May 7, 1997.

Interviews with 1703<sup>rd</sup> EOD members: May 27, 1997, CMAT number: 1997121-0000012, May 6, 1997, CMAT number: 1997118-0000043; March 3, 1997, CMAT number: 1997063-004; May 29, 1997, CMAT number: 1997141-0000055; May 14, 1997, CMAT number 1997121-0000014.

*Iraqi Chemical Warfare: Analysis of Information Available to DoD*, Department of Defense Intelligence Oversight Committee Report, Classified Draft, June 1997.

Response to RII-2093, GulfLINK.

RII 1877-IZ CW/BW capabilities, GulfLINK.

Testimony at the Presidential Advisory Committee on Gulf War Veteran's Illnesses, Public Hearing, Buffalo, NY, July 29, 1997.



## ***TAB D - Methodology For Chemical Incident Investigation***

The DOD requires a common framework for our investigations and assessments of chemical warfare agent incident reports, so we turned to the United Nations and the international community which had experience concerning chemical weapons. Because the modern battlefield is complex, the international community developed investigation and validation protocols<sup>50</sup> to provide objective procedures for possible chemical weapons incidents. The standard that we are using is based on these protocols that include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation, or human or animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by an expert panel.

While the DOD methodology for investigating chemical incidents (Figure 4) is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, the methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. The major efforts in this methodology are:

- Substantiate the incident.
- Document the medical reports related to the incident.
- Interview appropriate people.
- Obtain information available to external organizations.
- Assess the results.

Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

To substantiate the circumstances surrounding an incident, the investigator searches for documentation from operational, intelligence, and environmental logs. This focuses the investigation on a specific time, date, and location, clarifies the conditions under which the incident occurred, and determines whether there is "hard" as well as anecdotal evidence. Additionally, the investigator looks for physical evidence that might indicate that chemical agents were present in the vicinity of the incident, including samples (or the results of analyses of samples) collected at the time of the incident.

The investigator searches the medical records to determine if personnel were injured as a result of the incident. Deaths, injuries, sicknesses, etc. near the time and location of an incident may be telling. Medical experts should provide information about alleged chemical casualties.

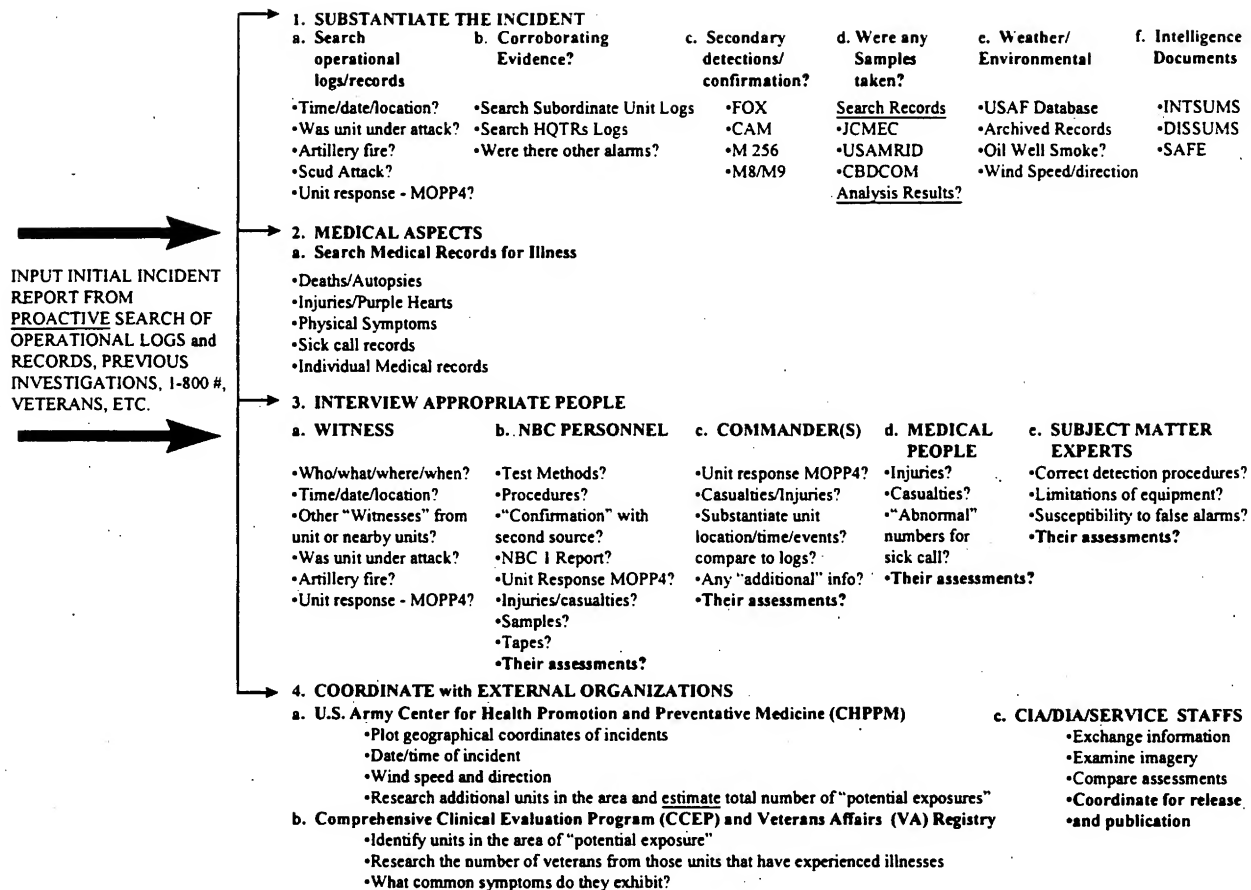


Figure 4. Chemical Incident Investigation Methodology

Interviews of incident victims (or direct observers) are conducted. First-hand witnesses provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved, and are particularly important if physical evidence is lacking. NBC officers or personnel trained in chemical and biological testing, confirmation, and reporting are interviewed to identify the unit's response, the tests that were run, the injuries sustained, and the reports submitted. Commanders are contacted to ascertain what they knew, what decisions they made concerning the events surrounding the incident, and their assessment of the incident. Where appropriate, subject matter experts also provide opinions on the capabilities, limitations, and operation of technical equipment, and submit their evaluations of selected topics of interest.

Additionally, the investigator contacts agencies and organizations that may be able to provide additional clarifying information about the case. These would include, but not be limited to:

- Intelligence agencies that might be able to provide insight into events leading to the event, imagery of the area of the incident, and assessments of factors affecting the case.
- The DOD and Veterans' clinical registries, which may provide data about the medical condition of personnel involved in the incident.

*TAB E - Photos of Tallil Air Base*

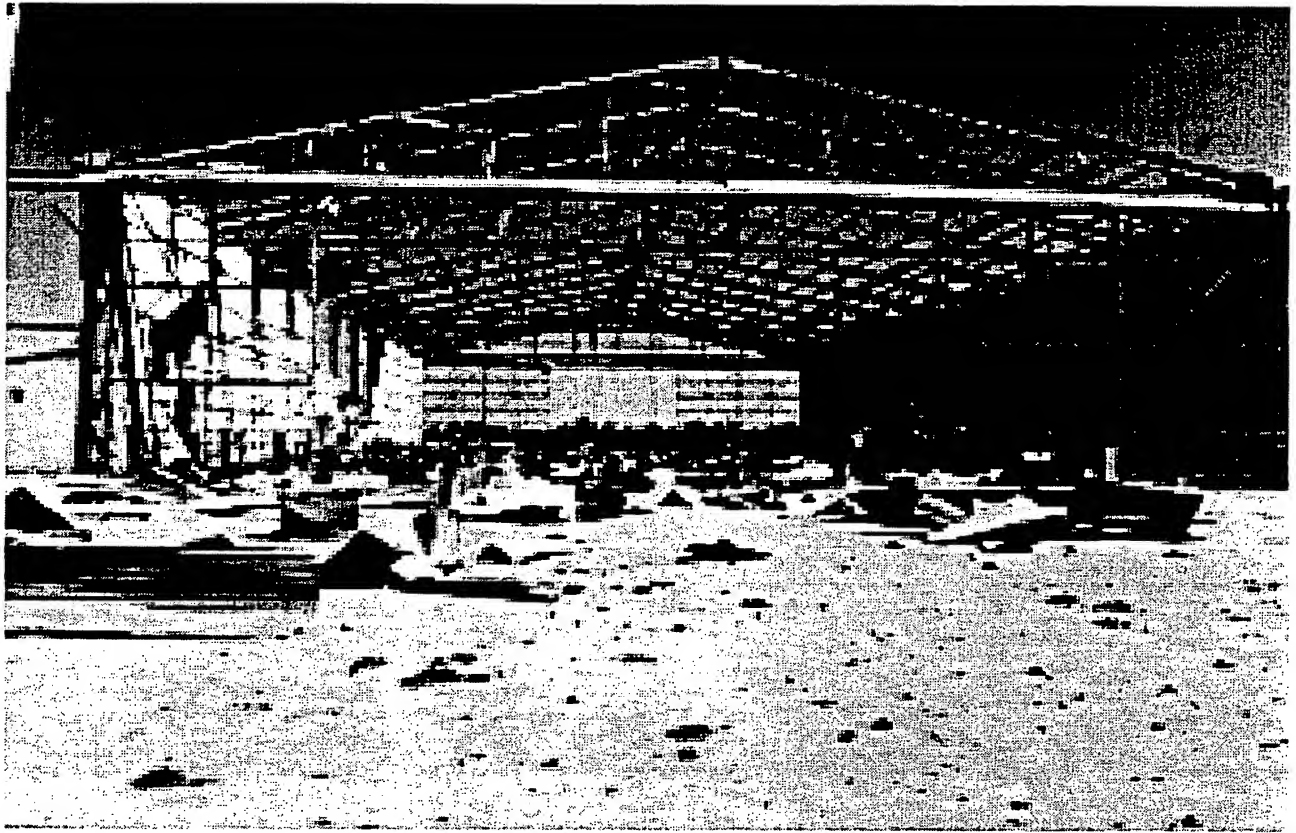


Figure 5. Blast damaged Aircraft Maintenance Hanger.



Figure 6. Bomb-damaged Hardened Aircraft Shelters.



Figure 7. Destroyed Aircraft Inside Damaged Aircraft Shelter.

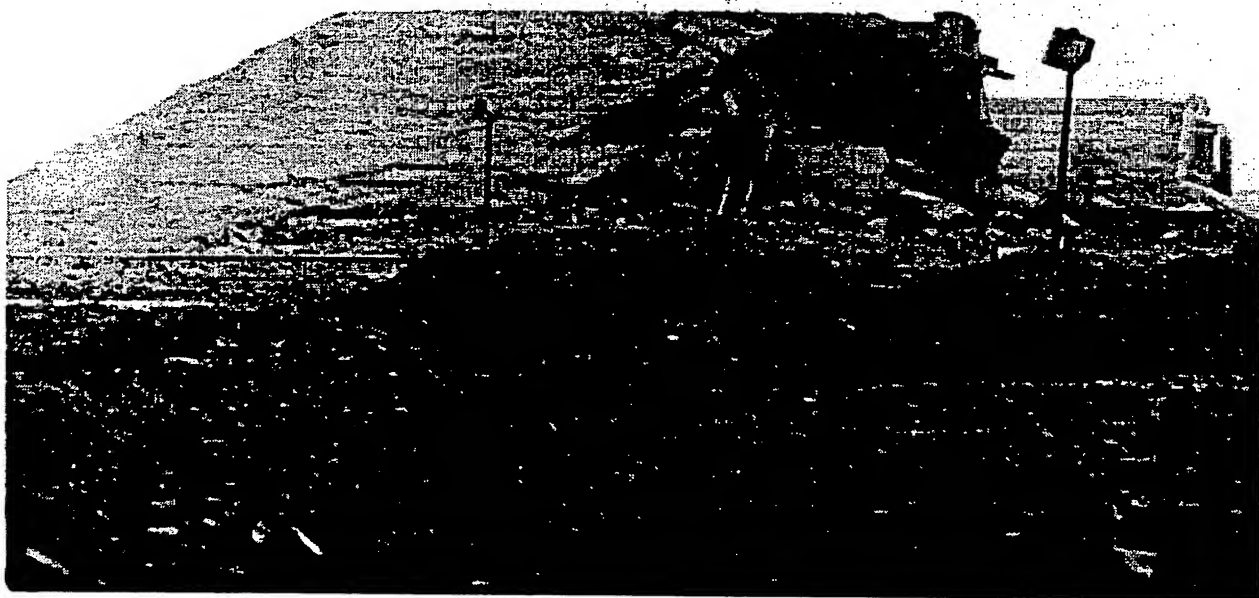


Figure 8. Damaged Earth-covered Hardened Aircraft Shelter.



Figure 9. Close-up of Damaged Entrance to Hardened Aircraft Shelter.



# Information Paper

## Mission Oriented Protective Posture (MOPP) And Chemical Protection

Information Papers are reports of what we know today about military equipment and its use during the Gulf War of 1990-1991. This particular information paper focuses on Mission Oriented Protective Posture (MOPP) and chemical protection. It describes the protective clothing and equipment worn by forces to protect against possible exposure to chemical or biological agents. It also describes the levels of protection and how our forces managed these to maximize safety while preserving mission capability during the Gulf War. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the issues reported here. With your help, we will be able to report more accurately on the events surrounding the use of MOPP and protective equipment. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997265-0000-019

Last Update: October 30, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1995 to investigate all possible causes. The Investigation and Analysis Directorate (IAD) of the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) assumed responsibility for these investigations on November 12, 1996 and has continued to gather information on MOPP and chemical protection. IAD's interim report is contained here.

As part of the effort to inform the public about the progress of this effort, DoD is publishing (on the Internet and elsewhere) accounts and background related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling the accounts. The following information paper will aid in understanding incidents involving protective clothing and equipment worn in the Gulf War.

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## I. SUMMARY

This Information Paper provides basic information on Mission Oriented Protective Posture (MOPP) procedures, as well as information about the protective clothing and equipment used by US forces during the 1990-91 Gulf War. It supplements other information papers and narratives referring to MOPP.

Flexible use of specialized clothing and equipment protects the wearer against nuclear, biological, and chemical (NBC) contamination on the battlefield. Such Chemical Protective Equipment (CPE), which includes clothing, can drastically cut the potential of chemical exposure and casualties and reduce the impact of chemical weapons on combat operations. The United States and its allies have been developing and refining protective gear for decades. However, US forces have not faced confirmed offensive NBC attacks since taking chemical casualties in World War I—almost 80 years ago. While tests have indicated US CPE is effective, until the Gulf War, it had not been tested in an NBC combat environment.

The protective clothing shown in Figure 1 protects troops during support and combat operations in a potentially contaminated environment.

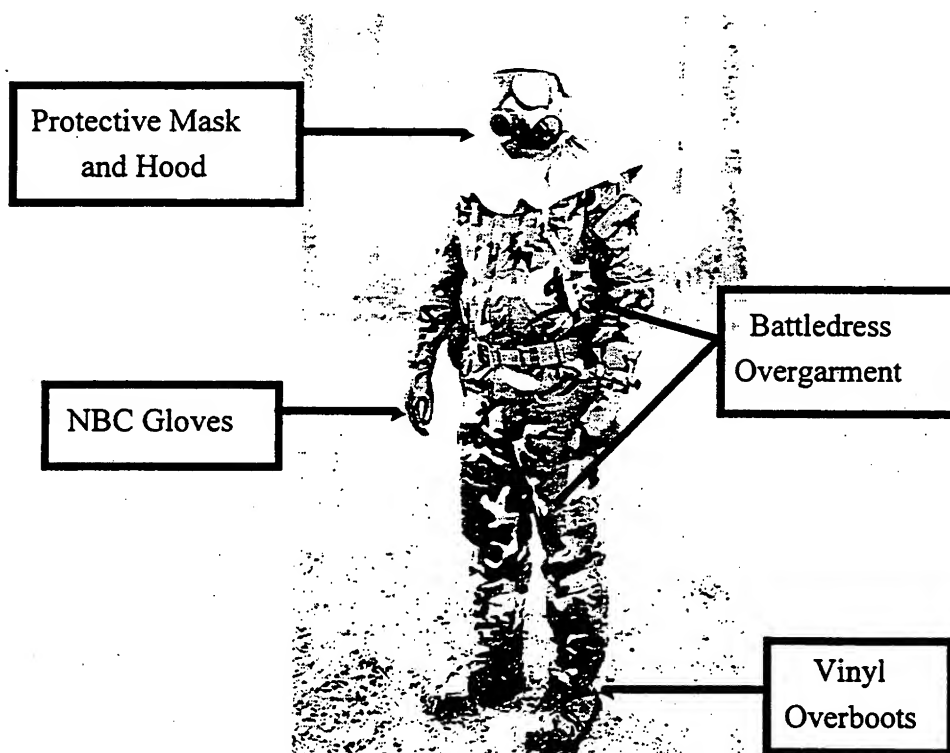


Figure 1. Individual CPE (MOPP Level 4).<sup>1</sup>

<sup>1</sup> Field Manual No 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-3.

Wearing CPE can degrade combat performance because of heat buildup and difficulty seeing, hearing, speaking, eating, drinking, moving, handling equipment or supplies, and sometimes thinking. Therefore, commanders must balance the need for NBC protection with mission requirements. Commanders adjust the level of protection (i.e., what protective equipment to wear) based on the threat of NBC attack and the impact of such wear on military operations. Each increase in MOPP Level involves donning more gear and accepting greater degradation in performance.<sup>2</sup>

According to current doctrine, as MOPP levels increase, Chemical Protective Equipment (CPE) is added to the equipment worn at lower levels. Each increase in the MOPP Level reduces the time troops must take to attain MOPP Level-4 and full protection. When the threat of chemical warfare agent use is high, commanders may establish a standing MOPP level (other than MOPP-0) for troops during military operations. In the event of a chemical attack, this effectively reduces the time required to attain MOPP-4. For example, during the first hours of the ground war, Task Force Ripper was at MOPP-2. When a chemical warning sounded, it took less time for Task Force Ripper troops to attain MOPP-4 than if they were at MOPP-0.

- MOPP Level 0 -- None of the protective clothing and equipment is worn, but it is readily available.
- MOPP Level 1 -- The overgarment and helmet cover are worn.
- MOPP Level 2 -- Overboots are added.
- MOPP Level 3 -- Chemical protective mask and hood are added. At this point personnel are completely encapsulated.
- MOPP Level 4 -- Butyl rubber gloves are added.<sup>3</sup>

The protective overgarment and hood can cause body heat buildup, which can lead to heat exhaustion in warmer weather. The protective mask and hood degrade the ability to see, speak, and hear. The rubber gloves restrict air circulation and limit the sense of touch and the ability to perform tasks requiring delicate manipulation. The wearing of full CPE can cause psychological stress (e.g., claustrophobia) in some people. All of these problems can reduce combat effectiveness. Therefore, commanders are given flexibility in adjusting the MOPP levels to meet mission requirements, environmental conditions, and the threat of NBC exposure.<sup>4</sup>

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<sup>2</sup> Field Manual No 3-100, *NBC Operations*, HQ, Department of the Army, Washington, DC 17 September 1985, p. 3-3.

<sup>3</sup> Field Manual No 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-2 to 2-4.

<sup>4</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-11 - 2-12.

In the Gulf War, the US was very concerned that Iraq might use chemical weapons (CW).<sup>5</sup> During Iraqi SCUD missile attacks against coalition bases, US forces donned chemical protective clothing in response to attack warnings or sirens. Throughout the ground combat phase, many US Army and Marine Corps forces at the front were at some increased MOPP level (Level 1-4).<sup>6</sup>

## II. TECHNICAL CHARACTERISTICS

### A. Chemical Protective Equipment (CPE) Components

The key parts of CPE include:

- *Overgarment.* US forces in the Gulf War had several models of overgarment. (If exposed to contamination, the wearer discarded and replaced overgarments. They were not decontaminated or recycled. Troops normally wore the overgarment over the field uniform, but it could be worn over only underwear to reduce heat buildup.)<sup>7</sup>
  - The Battledress Overgarment (BDO) consisted of a coat and trousers in olive drab or camouflage pattern. The BDO has an outer cotton layer and an inner layer of charcoal impregnated polyurethane foam. It is permeable, permitting some air to filter in and out—thereby reducing heat buildup, while absorbing and trapping any chemical agents coming in contact with the BDO.
  - Many troops in Operation Desert Shield deployed with the Chemical Protective Overgarment (CPOG), similar in construction to the BDO, but older in design. It is solid olive drab with an outer layer of nylon cotton and charcoal impregnated foam inside.
  - Army aircrews wore the Aircrew Uniform Integrated Battlefield (AUIB) instead of a normal flight suit or the BDO/CPOG. It protects against both chemical hazards and fire and includes features specialized for use in the cockpit.<sup>8</sup>

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<sup>5</sup> After the war, General H. Norman Schwarzkopf noted: "I also worried about the great empty area of southern Iraq where the Army would launch its attack. I kept asking myself, 'What does Saddam know about that flank that I don't? Why doesn't he have any forces out there?' They then nicknamed the sector the 'chemical killing sack.' I'd flinch every time I heard it. I had a nightmare vision of Fred Franks and Gary Luck hitting that area only to have the Iraqis dump massive quantities of chemicals while the Republican Guard counterattacked and fought us to a stalemate. I became increasingly jumpy." Quoted in Army Training Circular 3-10, *Commander's Tactical NBC Handbook*, Department of the Army, Washington, DC, 29 September 1994, p. 1-1.

<sup>6</sup> Manley, Captain T. F., *Marine Corps NBC Defense in Southwest Asia*, Marine Corps Research Center Research Paper #92-0009, July 1991, p. 10-11.

<sup>7</sup> Manley, Captain T. F., *Marine Corps NBC Defense in Southwest Asia*, Marine Corps Research Center Research Paper #92-0009, July 1991, p.40 and *Medical Management of Chemical Casualties Handbook*, Second Edition, September 1995, section on "Chemical Defense Equipment," US Army Medical Research Institute for Chemical Defense, Chemical Casualty Care Office, Aberdeen Proving Ground, MD, p. 4.

<sup>8</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-0 to 1-2 and 1-8.

- Marines had four different chemical protective suits: the *Marine Corps Standard Protective Overgarment* (OG84), the *Navy Lightweight Suit* (MKIII), the *Aviators Chemical Ensemble*, and the *British Lightweight Suit* (MK IV).
- Air Force aircrews also wore the *British Mark IV Lightweight Suit* (MK IV).
- *Chemical Protective Helmet Cover*. This cover protects against chemical and biological contamination and is made from butyl-coated nylon cloth. It has an elastic web in the hem to gather the cover and hold it on the helmet.<sup>9</sup>
- *Vinyl Overboot*. Worn over combat boots, the impermeable overboot protects against chemical, radiological, and biological hazards, as well as rain, mud, or snow. If contaminated, decontamination can return them to service.<sup>10</sup>
- *Protective Masks*. Several models of protective masks were used by the US military in the Gulf War. All the masks protect the face and airways from airborne contamination by all known chemical or biological agents and radioactive dust. In the Gulf War, most US troops in dismounted ground operations had the M17 Series Protective Mask.<sup>11</sup> Some troops had the newly fielded M40 Protective Mask. Both masks have similar basic functions and levels of protection, but the M40 is more comfortable, with improved convenience and voice transmission. They both include a binocular lens system, elastic head harness, voicemitters, and filters to trap NBC contaminants. The M17 Series is made of butyl rubber while the M40 facepiece is made of silicone with a second skin which is made of butyl rubber. Masks that could be connected to vehicle air filtration systems were issued to tank crews (M25) and aircrews (M24).<sup>12</sup> The Air Force ground personnel used the M17 Series Masks or the MCU-2/P series masks. The MCU-2/P is similar to the M40 except that it has a single large eye lens instead of two.
- *Field Protective Hood*. The hood attaches to and is donned with the mask. It protects the head and neck from chemical agents and other NBC hazards.<sup>13</sup>
- *Chemical Protective Glove Set*. The glove set includes outer gloves made of impermeable butyl rubber and inner gloves made of thin cotton to absorb moisture.<sup>14</sup> The outer gloves come in three thicknesses:

<sup>9</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-5.

<sup>10</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-4.

<sup>11</sup> The M17 Series includes the M17, M17A1, and the M17A2 protective masks. Most troops in the Gulf would have had the M17A1 or the M17A2.

<sup>12</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-5 to 1-8.

<sup>13</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-6.

<sup>14</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-3 to 1-4.

- The 7 mil gloves are used by medical personnel, teletype operators, electronic repair personnel, etc., who need high touch sensitivity and who normally will not expose the gloves to harsh treatment.
- The 14 mil gloves are used by aviators, vehicle mechanics, and weapon crews needing some touch sensitivity but who also are unlikely to give the gloves harsh treatment.
- The 25 mil gloves are used by troops who perform close combat tasks and other heavy labor.
- *Auxiliary Equipment.* Skin decontamination kits, antidote kits, and M8/M9 chemical agent detector paper also accompany the protective clothing as auxiliary equipment.<sup>15,16</sup>

## B. How CPE Protects Against Chemical Weapons (CW)

Before discussing how CPE is used in the field, it is useful to understand the types of chemical weapons it protects against and how. Chemical warfare agents may be delivered in various forms, including gas, liquid, or aerosol. They can be non-persistent (lasting for only minutes) or persistent (remaining effective for weeks). Chemical agent clouds can cover large areas and drift into foxholes, hatches, and bunkers to cause casualties.<sup>17</sup> Table 1 summarizes chemical warfare agent characteristics. Chemical Protective Equipment is designed to protect against both persistent and non-persistent agents.

Table 1. Types and Characteristics of Chemical Agents.<sup>18</sup>

Types of Agents	Symbol	Persistence		Rate of Action <sup>19</sup>	Entrance	
		Summer	Winter		Vapor/Aerosol	Liquid
Nerve	G-Agents	10 min to 24 hours	2 hr to 3 days	Very Quick	Eyes, Lungs	Eyes, Skin, Mouth
	V-Agents	2 days to 1 week	2 days to weeks	Quick	Eyes, Lungs	Eyes, Skin, Mouth
Choking	CG, DP	1 to 10 min	10 min to 1 hr	Slow	Lungs	Eyes
Blister	HD, HN	3 days to 1 week	Weeks	Slow	Eyes, Skin, Lungs, Eyes, Skin, Lungs	Eyes
	L	1 to 3 days	Weeks	Quick	Lungs	Eyes, Skin, Mouth
	CX	Days	Days	Very Quick		
Blood	AC, CK	1 to 10 min	10 min to 1 hr	Very Quick	Lungs	Eyes, Injured Skin

<sup>15</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-9 - 1-13

<sup>16</sup> M8 and M9 paper are used to detect liquid chemical contamination.

<sup>17</sup> Field Manual No. 3-100, *"NBC Operations,"* HQ, Department of the Army, Washington, DC, 17 September 1985, p. 1-11.

<sup>18</sup> Field Manual No. 3-100, *"NBC Operations,"* HQ, Department of the Army, Washington, DC, 17 September 1985, p. 1-12.

<sup>19</sup> The Rate of Action is the time required for symptoms to appear in a person exposed to a particular agent. The rate of action is affected by the route of entry into the body. For example, symptoms for nerve agent vapor can effect the eyes and lungs within minutes of exposure, while blisters from mustard exposure may not develop for up to 8 hours. Army TM 8-285, Navy NAVMED P-5041, Air Force AFM 160-12, *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, May 1974.

The special filters in the protective masks absorb airborne agents and protect the lungs and eyes. The other components of CPE protect against agent contact with the skin—regardless of whether it comes in solid, liquid, or vapor form.<sup>20</sup> The overboots and butyl rubber gloves are impermeable and provide a solid barrier to liquid agents. A solid barrier for the rest of the body is not practical for most combat functions because it would cause the rapid buildup of body heat and moisture. Overgarments and hoods permit some passage of air and moisture through two layers, allowing perspiration to evaporate. The outer layer limits liquid absorption or redistributes it to reduce concentration. An inner layer filters the air and any vapor that penetrates the outer layer. This inner layer of charcoal-impregnated foam acts like the filter in the protective mask. Charcoal is highly porous and able to absorb liquid, gas, and aerosol agents.<sup>21</sup> If mask filters or permeable protective garments become exposed to a chemical agent, they are discarded (and properly disposed of) after wear and then replaced, in accordance with each service's doctrine. For example, the Air Force chooses to air out vapor-contaminated CPE in a toxic free area, and then reuse them. Impermeable gloves and overboots can be decontaminated and recycled for use.<sup>22</sup>

Troops potentially exposed to high concentrations of chemical warfare agents (e.g., decontamination crews) receive special impermeable overgarments.<sup>23</sup>

### C. CPE Related to MOPP Levels

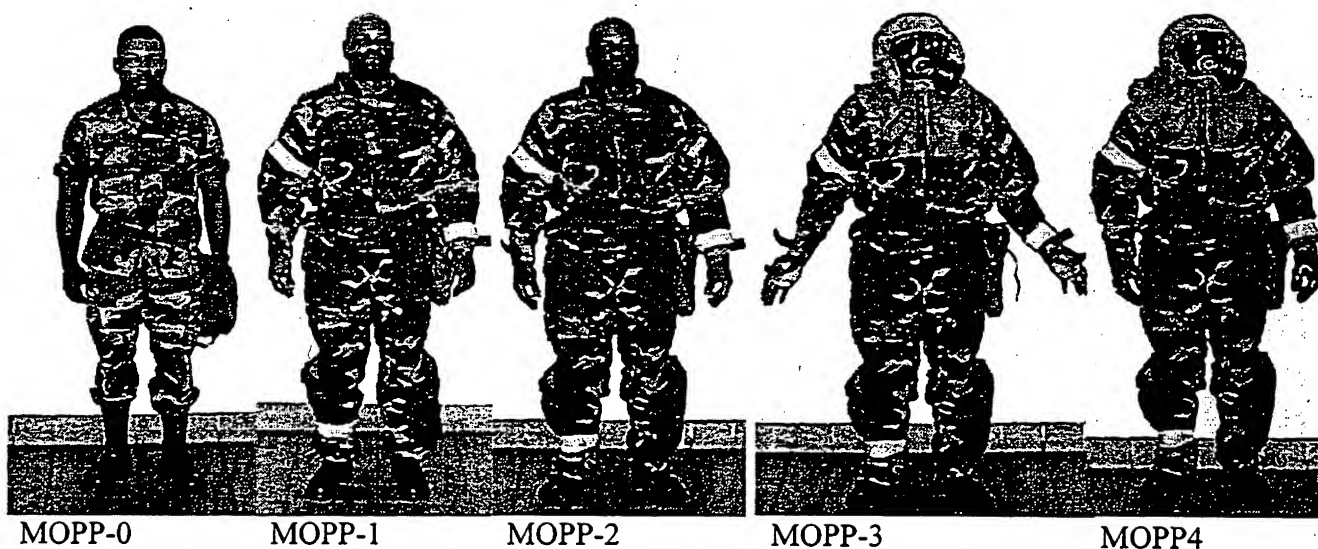


Figure 2. CPE Worn at Each MOPP Level.<sup>24, 25</sup>

<sup>20</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-0, 1-1, 1-4, 1-5.

<sup>21</sup> Extracts, *History of CP Overgarment*, undated.

<sup>22</sup> Air Force Manual 32-4005, *Personnel Protection and Attack Actions*, Department of the Air Force, Washington, DC, 1 October 1995, Attachment 2 section A2.11.

<sup>23</sup> Field Manual No. 3-100, *"NBC Operations,"* HQ, Department of the Army, Washington, DC, 17 September 1985, p.1-2 and 1-3.



Table 2. Wear of CPE by MOPP Level.<sup>26</sup>

EQUIPMENT	MOPP 0	MOPP1	MOPP2	MOPP3	MOPP4
Overgarment and Helmet Cover	Available <sup>27</sup>	Worn	Worn	Worn	Worn
Vinyl Overboot	Available	Available	Worn	Worn	Worn
Mask and Hood	Carried	Carried	Carried	Worn	Worn
Gloves	Available	Carried	Carried	Carried	Worn

Table 2 provides more detail on standard MOPP Level procedures. While in buildings and vehicles that offer some protection against liquid agents, troops may operate in a modified MOPP posture to protect against vapor threats. Some vehicles (such as the M1A1 Abrams Tank) have air pumped in through filters (overpressure systems), permitting a mask-free operation in contaminated terrain.<sup>28</sup> Troops assume the MOPP level set by the commander when they exit these special environments.

To maintain effectiveness in MOPP Levels 3 or 4, commanders can declare "MOPP Open." This permits troops to open the jacket and roll up the hood to improve ventilation for a limited period of time based on estimates of the chemical threat.<sup>29</sup>

#### D. Donning Time for CPE

As troops put on more protective clothing and equipment, and the MOPP level continues to increase, the time required to achieve the higher levels of protection decreases. For example, increasing the MOPP level from MOPP Level 0 to MOPP Level 1 cuts the incremental time to go to MOPP-4 in half (from eight to four minutes). Increasing the MOPP level from MOPP-1 to MOPP-2 cuts the time to go to MOPP-4 from four minutes to under a minute. Figure 3 shows the amount of time necessary to attain MOPP-4 from each lower MOPP Level.

<sup>24</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-3.

<sup>25</sup> The soldiers in the pictures in Figure 2 are not wearing head coverings. While performing military operations all personnel wear helmets. At MOPP levels other than MOPP-0 personnel may also wear Chemical Protective Helmet Cover.

<sup>26</sup> Derived from Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-3

<sup>27</sup> Different sources interpreted "readily available" in different ways -- from within arms reach to within one minute away. XVIII Airborne Corps message 040645Z January 1991, Subject: *Mission Oriented Protective Posture (MOPP)*, p. 3 ; and TAB A to Appendix 2 to Annex C to (USMC) Direct Support Command Operations Order 1-91, *Chemical Warfare*, Direct Support Command, 6 February 1991, p. 1.

<sup>28</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-4.

<sup>29</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 3-10 and 3-11.

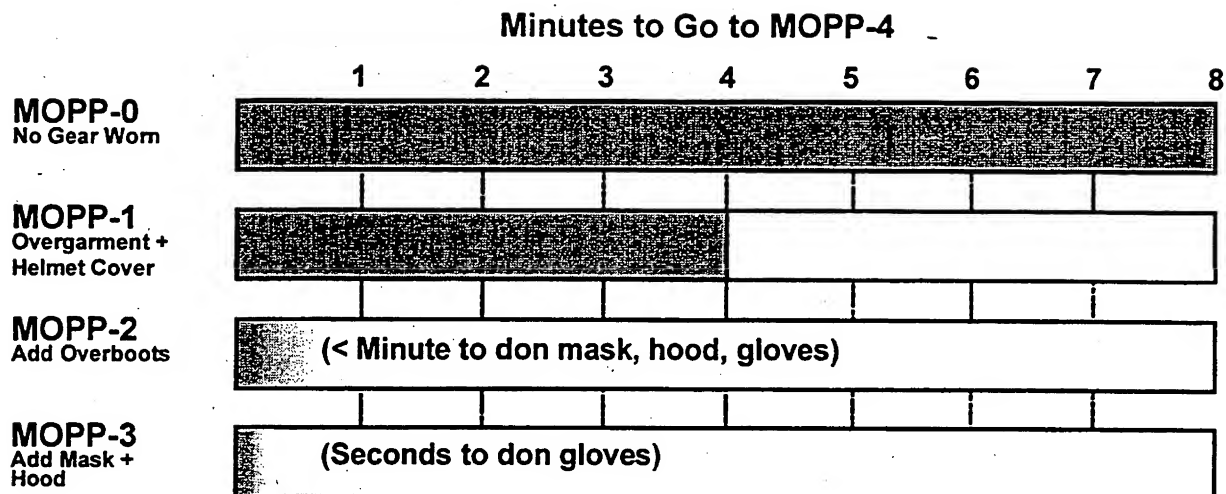


Figure 3. MOPP Level and Time to Go to MOPP-4.<sup>30</sup>

### III. OPERATIONAL USE AND LIMITATIONS

#### A. CPE Wear Time

CPE components are rated for how long they provide full protection in both contaminated and non-contaminated environments. For example, in a contaminated environment, the Chemical Protective Overgarment (CPOG) is rated for up to six hours of protection and the Battledress Overgarment (BDO) for 24 hours.<sup>31</sup> Overgarments actually exposed to chemical warfare agents are never worn again.

In a non-contaminated environment, the CPOG gradually begins to lose protection after 14 days of almost full time wear, while the BDO can last 30 days. Returning the garments to their vapor-seal bags "stops the clock" on these wear periods.<sup>32</sup> The bag protects the overgarment from the degrading effects of such things as moisture, smoke, fuel solvent vapors, and sunlight.<sup>33</sup> Over time, extensively worn overgarments can also become unserviceable because the charcoal migrates to the end of the sleeves and trousers, or the knees and elbows wear out, or the garment is exposed to too much mud and dirt.<sup>34</sup> Because of the limited availability in the Gulf of replacement CPE, commands were flexible about wear time in a non-contaminated environment under CW threat. It was decided that wearing an overgarment beyond the established full

<sup>30</sup> Derived from Field Manual No. 3-100, "NBC Operations," HQ, Department of the Army, Washington, DC, September 17, 1985, p. 3-4.

<sup>31</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-1 - 1-2.

<sup>32</sup> Memorandum for US Central Command Army LNO Team F, Subject: *Chemical Protective Overgarments*, AFRD-DTO, 8 February 1991.

<sup>33</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 1-1.

<sup>34</sup> Commander, XVIII Airborne Corps (G3) message 231215 Jan 91, subject: *Chemical Overgarment Wear Life and Serviceability*, p. 2.

protection limits would put troops at less risk than being exposed to chemical warfare agents without sufficient replacement protective gear.<sup>35</sup>

## **B. Performance Degradation Caused by CPE Wear**

Depending on the outside temperature and the physical level of work, MOPP postures above Level 0 can result in the following individual performance limitations:<sup>36</sup>

- Speech and communications problems
- Impaired hearing
- Reduced vision (acuity, field of view, depth perception)
- Difficulty recognizing individuals in MOPP
- Heat injuries
- Dehydration<sup>37</sup>
- Inadequate nutrition<sup>38</sup>
- Combat stress
- Mood swings and claustrophobia
- Impaired thinking and judgment

In recent years, the impacts of these kinds of effects (at MOPP Level 4) on combat operations have been studied extensively in Army field exercises. The following is a compendium of observations taken from reports on these studies:

- In a variety of tasks, degradation is 20 to 50 percent.<sup>39</sup>
- Oxygen consumption increases about 10 percent in full CPE compared to light clothes.<sup>40</sup> This indicates that personnel in MOPP-4 expend more energy than personnel in MOPP-0 performing the same tasks.
- Reduced sensory awareness makes it harder to stay awake when tired.<sup>41</sup>

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<sup>35</sup> Commander, US Army Central Command Main message 091035Z Feb 91, Subject: *Determination of Mission Oriented Protective Posture (MOPP)*, 9 February 1991, pp. 5-6.

<sup>36</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, pp. 2-6 to 2-12.

<sup>37</sup> For example, the Marines estimated water consumption at about double normal. HQ US Marine Corps/LRCC message 130148Z August 1990, Subject: *Care and Use of Chemical Protective Overgarment 84 (OG84)*, paragraph 1d.

<sup>38</sup> Inadequate nutrition affects personnel at MOPP 3 and 4, when the protective mask cannot be removed for several days or weeks.

<sup>39</sup> Technical Report, *Assessment of Performance of Tasks by Personnel Dressed in Chemical Protective Clothing*, Technical Analysis and Information Office, U.S. Army Dugway Proving Ground, Dugway, Utah, June 1987, p. 1.

<sup>40</sup> *Acclimatization and Adaptation for Troops in a Mission-Oriented Protective Posture (MOPP)*, Joint Operational Test & Information Directorate, U.S. Army Dugway Proving Ground, Dugway, Utah, October 1991, p. 9.

- Soldiers require 1.5 to 3 times longer to perform tasks requiring manual dexterity in MOPP-4 than without CPE.<sup>42</sup>
- Performing a task for the first time takes about 30 percent longer.<sup>43</sup>
- Troops tend to omit or poorly complete certain tasks (such as camouflage and support activities).<sup>44</sup>
- Some cognitive tasks, like encoding, suffer a performance loss of nearly 23 percent in MOPP-4.<sup>45</sup>
- Leader performance declines: they become exhausted, sleep less, become disoriented or lost, get irritable, and delegate less. Leaders often are the first MOPP casualties.<sup>46</sup>
- Unit movement formations bunch up to help leaders maintain control.<sup>47</sup>
- When platoon leaders become casualties, it takes four times as long for a platoon to realize it is leaderless. The next senior soldier assumes command 85% less often than in non-CPE exercises.<sup>48</sup>
- NBC Overboots provide poor footing on hilly terrain, on loose ground, or in rain.<sup>49</sup>
- NBC garments absorb rain and become very heavy and cumbersome.<sup>50</sup>
- Rifle marksmanship drops about 15 to 19 percent for soldiers in MOPP-4.<sup>51</sup>

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<sup>41</sup> Joint Publication 3-11, *Joint Doctrine for Nuclear, Biological, and Chemical (NBC) Defense*, The Joint Chiefs of Staff, The Pentagon, Washington, DC, p. II-10.

<sup>42</sup> *Acclimatization and Adaptation for Troops in a Mission-Oriented Protective Posture (MOPP)*, Joint Operational Test & Information Directorate, U.S. Army Dugway Proving Ground, Dugway, Utah, October 1991, p. v.

<sup>43</sup> Technical Report, *Assessment of Performance of Tasks by Personnel Dressed in Chemical Protective Clothing*, Technical Analysis and Information Office, U.S. Army Dugway Proving Ground, Dugway, Utah, June 1987, p. 1.

<sup>44</sup> *Summary Evaluation Report - Phase I*, Combined Arms in a Nuclear/Chemical Environment, US Army Chemical School, Fort McClellan, Alabama, March 1986, p. 1-3.

<sup>45</sup> *Acclimatization and Adaptation for Troops in a Mission-Oriented Protective Posture (MOPP)*, Joint Operational Test & Information Directorate, U.S. Army Dugway Proving Ground, Dugway, Utah, October 1991, p. 7.

<sup>46</sup> *Summary Evaluation Report - Phase I*, Combined Arms in a Nuclear/Chemical Environment, US Army Chemical School, Fort McClellan, Alabama, March 1986, p. 1-2.

<sup>47</sup> *Test Report - Force Development Test and Experimentation - Combined Arms in a Nuclear/Chemical Environment - Close Combat Light*, United States Army Test and Experimentation Command, Fort Hood, Texas, November 1992, p. vi.

<sup>48</sup> *Summary Evaluation Report - Phase I*, Combined Arms in a Nuclear/Chemical Environment, US Army Chemical School, Fort McClellan, Alabama, March 1986, p. 1-2.

<sup>49</sup> *Test Report - Force Development Test and Experimentation - Combined Arms in a Nuclear/Chemical Environment - Close Combat Light*, United States Army Test and Experimentation Command, Fort Hood, Texas, November 1992, p. vi.

<sup>50</sup> *Test Report - Force Development Test and Experimentation - Combined Arms in a Nuclear/Chemical Environment - Close Combat Light*, United States Army Test and Experimentation Command, Fort Hood, Texas, November 1992, p. vi.

<sup>51</sup> *Acclimatization and Adaptation for Troops in a Mission-Oriented Protective Posture (MOPP)*, Joint Operational Test & Information Directorate, U.S. Army Dugway Proving Ground, Dugway, Utah, October 1991, p. 10.

- Individual weapon firing rates decrease 20 percent in the defense and 40 percent in the attack. It takes twice as long to complete an attack, and nearly twice as many soldiers are required for success.<sup>52</sup>
- The proportion of enemy personnel engaged decreases by one-third.<sup>53</sup>
- Weapon crews use terrain much less effectively for cover and concealment, and the number of casualties suffered per enemy defender killed increases by 75 percent.<sup>54</sup>
- Shots fired at friendly instead of enemy soldiers increases from 5 to almost 20 percent.<sup>55</sup>
- Platoons call for three times more indirect fire (e.g., artillery). Indirect fire becomes more effective than individual weapons in inflicting casualties on the enemy.<sup>56</sup>
- Land navigation is seriously degraded, particularly at night.<sup>57</sup>
- Night vision devices cannot be used while masked.<sup>58</sup>
- Radio communication is difficult because of reduced clarity and volume.<sup>59</sup> Speaking through the voicemitter makes the speaker sound brassy and muffled, and consonants become indistinct. The hood and background noise (breathing, garment movement, etc.) degrades hearing.<sup>60</sup>
- Communications are only about half as effective as in a non-CPE environment. Total time spent on radio traffic more than doubles. The number and length of radio transmissions rises by 50 percent.<sup>61</sup>
- Logistics operations take longer and can become confused.<sup>62</sup>

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<sup>52</sup> *Summary Evaluation Report - Phase I, Combined Arms in a Nuclear/Chemical Environment*, US Army Chemical School, Fort McClellan, Alabama, March 1986, p. 1-3.

<sup>53</sup> *Summary Evaluation Report - Phase I, Combined Arms in a Nuclear/Chemical Environment*, US Army Chemical School, Fort McClellan, Alabama, March 1986, p. 1-3.

<sup>54</sup> *Summary Evaluation Report - Phase I, Combined Arms in a Nuclear/Chemical Environment*, US Army Chemical School, Fort McClellan, Alabama, March 1986, p. 1-3.

<sup>55</sup> *Summary Evaluation Report - Phase I, Combined Arms in a Nuclear/Chemical Environment*, US Army Chemical School, Fort McClellan, Alabama, March 1986, p. 1-3.

<sup>56</sup> *Summary Evaluation Report - Phase I, Combined Arms in a Nuclear/Chemical Environment*, US Army Chemical School, Fort McClellan, Alabama, March 1986, p. 1-3.

<sup>57</sup> Training Circular 3-1, *Commander's Tactical NBC Handbook*, Headquarters, Department of the Army, Washington, DC, 3 December 1993, p. 5-4.

<sup>58</sup> *Test Report - Force Development Test and Experimentation - Combined Arms in a Nuclear/Chemical Environment - Close Combat Light*, United States Army Test and Experimentation Command, Fort Hood, Texas, November 1992, p. vi.

<sup>59</sup> *Test Report - Force Development Test and Experimentation - Combined Arms in a Nuclear/Chemical Environment - Close Combat Light*, United States Army Test and Experimentation Command, Fort Hood, Texas, November 1992, p. vi.

<sup>60</sup> *Acclimatization and Adaptation for Troops in a Mission-Oriented Protective Posture (MOPP)*, Joint Operational Test & Information Directorate, U.S. Army Dugway Proving Ground, Dugway, Utah, October 1991, p. 10.

<sup>61</sup> *Summary Evaluation Report - Phase I, Combined Arms in a Nuclear/Chemical Environment*, US Army Chemical School, Fort McClellan, Alabama, March 1986, p. 1-2 - 1-3.

<sup>62</sup> Training Circular 3-1, *Commander's Tactical NBC Handbook*, Headquarters, Department of the Army, Washington, DC, 3 December 1993, p. 5-3.

- Maintenance takes longer. Recovering armored vehicles takes up to 20 percent more time; repairing weapons takes up to 70 percent more time.<sup>63</sup>

Training for key combat tasks in CPE can reduce such performance degradation.

### C. MOPP Level Analysis

Depending on the tactical situation, commanders choose the appropriate MOPP level. Before making a decision, the commander must address the following issues:<sup>64</sup>

- Nature of the mission (offensive or defensive).
- Likelihood of CW use and what agents might be used
- Likely friendly targets
- Expected warning time
- Additional available protection (shelter or cover)
- Physical demands of the projected work
- Mental demands of the projected work
- Speed required for mission accomplishment
- Expected duration of the mission
- Likely follow-on mission
- Whether adequate water and food supplies are available

Commanders must also consider other factors when setting the MOPP level. For example, the most likely time for a chemical attack is between late evening and early morning, when agent vapor tends to linger close to the ground. In the heat of the day, agents rise rapidly in unstable air.<sup>65</sup>

### D. Commander's Guidance

Commanders should use MOPP flexibly to protect their forces in a potential or actual Chemical Warfare situation. While the various headquarters provide initial directives on MOPP level, subordinate units often adapt this guidance to local conditions when warranted (although a commander generally sets a minimum MOPP level). Units can increase the MOPP level set by higher headquarters in response to direct threats.<sup>66</sup>

<sup>63</sup> Training Circular 3-1, *Commander's Tactical NBC Handbook*, Headquarters, Department of the Army, Washington, DC, 3 December 1993, p. 5-3.

<sup>64</sup>Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-17.

<sup>65</sup>Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. A-3.

<sup>66</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-22.

Because Gulf War commanders often had to use their own judgment in setting MOPP levels, different units experienced different degrees of CPE wear under similar circumstances. For example, after the first 24 hours of the ground war, the commander of the 2d Marine Division had his forces take off their CPE. In the adjacent 1st Marine Division sector, Marines continued to wear some of their CPE throughout the ground offensive.<sup>67</sup>

### E. Reducing MOPP Level and Unmasking

Commanders downgrade the MOPP level as the threat decreases. Before a unit unmask in a potential chemical threat area, the unit's chemical detection equipment must determine if a chemical hazard exists. If such tests are negative, the next step is "selective unmasking." Figure 4 diagrams the process.

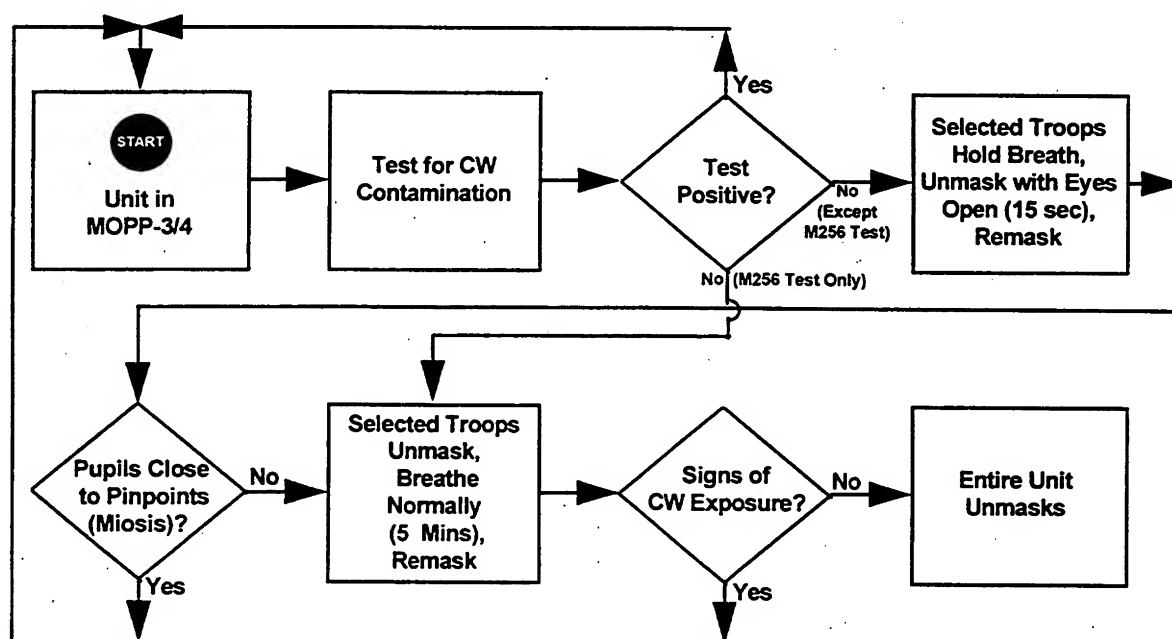


Figure 4. Selective Unmasking Process<sup>68</sup>

The M256 kit is the most sensitive vapor detection gear. If a unit must use a less sensitive test for an initial contamination check, full unit unmasking requires at least two limited unmaskings to confirm no contamination. First, one or two designated troops hold their breath, unmask for 15 seconds with their eyes open, and then remask. Others then observe their eyes for contraction of the pupils (miosis), the first sign of exposure to nerve agent vapor. If those who unmasked show no symptoms, they remove their masks and breathe normally for five minutes and remask while being observed for symptoms. If no symptoms appear, an all clear is sounded and the remaining troops of the unit unmask.

<sup>67</sup> *With the 1st Marine Division in Desert Shield and Desert Storm*, History and Museums Division, Headquarters, U.S. Marine Corps, Washington, DC, p. 145.

<sup>68</sup> Derived from Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-24.

When the sensitive M256 kit confirms no contamination, the procedure skips the first step involving eye exposure without breathing. All selective unmasking involves careful observation of the designated troops and immediate readiness to administer antidotes in response to any sign of toxic reaction.<sup>69</sup>

Procedures established for some Army units in the Gulf included an extra selective unmasking step after unmasking for 15 seconds without breathing. This step, used where no detection equipment was available, involved unmasking and taking two or three breaths and remasking for an additional 10 minutes of observation. If no symptoms appeared, the same soldiers unmasked for five minutes.<sup>70</sup>

#### **F. Automatic Masking**

In addition to establishing the MOPP Level, commanders set the guidance for automatic masking. Automatic masking means that no matter what the command-established MOPP Level, military personnel are expected to rapidly don masks if there is an immediate threat. For example, automatic masking could occur under any of the following conditions:<sup>71</sup>

- An automatic chemical agent alarm sounds.
- A chemical agent detector paper reads positive.
- Troops experience symptoms of a chemical agent exposure.

#### **G. Threat Level Color Codes**

Some US Air Force and Marine units in Operation Desert Storm used color codes to supplement MOPP levels. These codes generally referred to the immediacy of the chemical threat. The Marines' system included the following:<sup>72</sup>

- "White." Enemy forces have the capability to employ NBC weapons, but attack is not probable at this time.
- "Yellow." Attack probable, units maintain MOPP-0.
- "Red." Siren sounds. Attack is imminent. Units go to MOPP-4.
- "Black." Siren sounds. Friendly forces nearby have been attacked with CW. Units remain in MOPP-4 until "all clear" is given.

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<sup>69</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-24.

<sup>70</sup> HQ, 210th Military Police Battalion memorandum, subject: *Scud/Aerial Attack Procedures*, 21 September 1991, p. 4.

<sup>71</sup> Field Manual No. 3-4/Fleet Marine Force Manual No. 11-9, *NBC Protection*, HQ, Department of the Army/US Marine Corps, Washington, DC, 29 May 1992, p. 2-4.

<sup>72</sup> Memorandum from Commanding General, 1st Force Service Support Group, Subject: *Policy for NBC Defense Preparedness for 1st FSSG Personnel*, 13 October 1990, p. 2.



The Air Force had a similar system, with stages defined differently:<sup>73</sup>

- "All Clear." Normal Operations. Have Chemical Protective Equipment (CPE) and field gear readily available.
- "Alert Yellow." Attack is probable. Wear CPE and field gear as directed.
- "Alert Red." Attack is imminent or in progress. Don protective equipment (to include field gear) and take cover.
- "Alert Black." NBC contamination is suspected or actual. Wear full chemical protective ensemble and field gear.

An Air Force daily log for Al Kharj Air Force Base, Saudi Arabia included this entry for January 21, 1991:

"At 2200 hours the air base went on a Red Alert, MOP[P] Level IV. Personnel were warned to take cover but the alert was called off after a short period of time. Al Kharj Air Base was then put on a Yellow Alert, MOP[P] Level II which meant that people, for the second time in three nights, had to sleep in their chemical warfare gear."<sup>74</sup>

In late January, after SCUD missile attacks failed to include chemical warheads (and a need to conserve scarce overgarments became clear), the Air Force instituted MOPP Level ALPHA. This involved taking cover in a hallway or bunker, donning the mask, hood, and gloves, and ensuring full body coverage with long pants and long-sleeved shirts; no NBC overgarments were donned. If an attack actually ensued, ALARM BLACK MOPP ALPHA was to be declared. The overgarments, however, were to be left packed and at hand unless a chemical agent was actually detected. In that event, ALARM BLACK MOPP 4 would be issued and the overgarments would be donned.<sup>75</sup>

Despite these variations, the standard MOPP level system was the primary way of tying protection level to chemical agent threat for the majority of US forces during the Gulf War.<sup>76</sup>

## IV. ASSESSMENT OF EFFECTIVENESS

### A. Test Results and CPE Adequacy

Testing before the Gulf War established some limits to regular uncontaminated wear of the overgarments: the Battledress Overgarment (BDO) actually protected the wearer for 22 days, while the Chemical Protective overgarment (CPOG) protected for 14 days. In December 1990,

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<sup>73</sup> Attachment to US Central Command Air Force/Chief of Staff letter, Subject: *Attack Actions Handout*, 15 January 1991, p. 6.

<sup>74</sup> 4404 TFW(P) *Combat Operations Synopsis*, Day 5, 21 January 1991.

<sup>75</sup> "KKIA Activates MOPP Alpha," *The Sand Paper* newsletter, King Khalid International Airport, January 31, 1991.

<sup>76</sup> Commander, XVIII Airborne Corps message 031535Z Dec 90, Subject: *NBC Readiness*, 3 December 1990, p. 2.

additional testing indicated that the BDO's protection could extend to 30 days if the garments were not heavily worn or soiled. In addition, testing showed that garments in the vapor barrier bags with leaks or split seams did not degrade. Consequently, overgarments accidentally removed from the bags and left out for 72 hours or more were no longer relegated to a training-only status.<sup>77</sup> As noted above, additional guidance was issued in-theater for actual wear. Once exposed, the CPOG can only protect the wearer for 6 hours while the BDO will continue to protect troops for 24 hours.

Also in December 1990, XVIII Airborne Corps drew attention to the fact that 44 percent of the M17 protective masks tested at a repair facility in Saudi Arabia failed quality assurance tests. In 1984, a similar failure initiated a recall of all M17 series masks. Senior officers in the Army chemical community responded that the test equipment in the Saudi facility was designed to do rebuild testing and production acceptance tests more stringent than those required for field protection. The Commander of the Army Materiel Command did not believe a significant problem existed. Nevertheless, experts were dispatched to review the situation.<sup>78</sup>

At times during Operation Desert Shield, the media were critical of US CPE effectiveness. Prior to a news briefing in February 1991, the following information was offered to the press in anticipation of such criticism:

"The M17A1/A2 mask, although not the latest technology available...is one of the finest masks that has ever been developed and is being used by many countries throughout the world....The M40 mask represents the latest in protective mask technology and is currently in production by two US contractors. Limited quantities have already been provided to the soldiers in the AOR (area of responsibility)....Although the M17 series mask has an internal filter that requires more time to change than the screw-on canister type of the M40 mask, our doctrine does not advocate the exchange of either type of filters in a contaminated environment. The filter change out time for the M17 series mask has been reported by feather merchants wanting to sell their product as 15 to 20 minutes. A well trained soldier can accomplish the task in about five minutes. Although the M17 series mask reflects 1960s technology, it has been proven through extensive research to be fully capable of providing the protection level required...."<sup>79</sup>

In a related issue, about five percent of soldiers might not have been able to get a correct facial fit with the older masks (including the M17 series). On the other hand, the M40 was expected to fit nearly 100 percent of the military population. During Operation Desert Shield, the Army worked to get M40 prototypes for those difficult-to-fit troops.<sup>80</sup> Following the war, after-action reports observed that the push to field new NBC systems, including the M40, strained field support operations. The Army component of the US Central Command consequently suggested that only

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<sup>77</sup> Commander XVIII Airborne Corps (G3) message 220830Z Dec 90, subject: *Chemical Protective Overgarments*.

<sup>78</sup> Information Memorandum for the Chief of Staff, subject: *Mask Rework Operation*, Department of the Army, Washington, DC, 25 December 1990.

<sup>79</sup> Information provided in anticipation of question by news media during 11 Feb 91 evening news briefing, undated.

<sup>80</sup> US Army Office of the Surgeon General, *Preventive Medicine Situation Summary Report*, 13-26 October 1990.

mature, fully supportable systems should be fielded for contingencies, and that deployed units should be consulted on the decision.<sup>81</sup> The Air Force and Navy have since fielded the MCU-2A/P protective mask. By the year 2006, the four Services will have the Joint Service General Purpose Mask (JSGPM) in their inventories.

In the months before Operation Desert Storm, the Marine Corps purchased over 60,000 British Mark IV lightweight chemical overgarments.<sup>82</sup> They hoped to reduce reliance on the OG84 model, which caused more rapid body heat buildup in warm weather.

## **B. Lessons Learned**

Shortly after the Gulf War, first-hand observers made selected observations about MOPP and CPE. Overall, they stressed the need to plan, procure, and realistically train for operations in a Chemical Warfare environment. They also suggested ways to improve the use of MOPP in a desert theater.

The US Army 24th Infantry Division (Mechanized) had general and specific suggestions:

- Overall chemical defense equipment readiness needed improvement. As an NBC officer noted: "Our priority mission during the deployment and initial phases of DESERT SHIELD was monitoring the CPE readiness of the division. Since the system in place prior to deployment was inadequate, getting the division straight in CPE was a very painful process which took several months to mature."<sup>83</sup>
- There is a downside to wearing rubber gloves and boots in hot weather. "Hands are normally the least susceptible parts of the body to chemical exposure, but after being in rubber gloves for a while, they quickly became soft and very susceptible to chemical exposure and [physical] injury. Feet also become soft and can develop a variety of problems like trench foot." The Division recommended not wearing rubber gloves and boots in desert warfare unless direct exposure to liquid mustard agent is imminent. If troops must wear the gloves and boots, they recommended providing relief in uncontaminated areas before softening of the extremities becomes a problem.<sup>84</sup>
- Soldiers in combat tend not to shave every day—"especially in a desert environment where water is a precious commodity, if soldiers do not shave, they cannot get a good seal on their protective masks." The 24<sup>th</sup> Division recommended making it a command policy that every

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<sup>81</sup> ARCENT lessons learned report, subject: *New Equipment Fielding*, 4 April 1991.

<sup>82</sup> Commanding General, Marine Corps Research, Development, and Acquisition Command, message 010226Z Apr 91, subject: *Inventory of Lightweight Chemical Suits, British Mark IV*.

<sup>83</sup> 24th Mechanized Infantry Division Operation Desert Storm After Action Report, subject: *Chemical Defense Equipment Readiness*, 20 May 1991, p. 4.

<sup>84</sup> 24th Mechanized Infantry Division Operation Desert Storm After Action Report, subject: *Chemical Defense Equipment Readiness*, 20 May 1991.

male soldier shave every day, and that battery-powered electric shavers be provided to reduce water requirements.<sup>85</sup>

Wearing and carrying the mask daily through a robust training schedule in a windy, sandy environment damaged protective mask carriers—requiring a call for 400,000 carriers to be shipped to the theater. Borrowing from non-deploying units in other theaters helped provide replacement items.<sup>86</sup>

An Army engineer unit noted that NBC support at their post ranged from very good to nonexistent. Individual chemical protective equipment support was good, but chemical defense equipment (like batteries for the M8A1 alarm system) was unavailable. The unit suggested that units deploying to a hostile theater receive adequate stocks of NBC supplies prior to departure.<sup>87</sup>

Navy Field Hospital Five submitted several MOPP-related lessons it learned:

- The CPE packaging was difficult and time-consuming to open, and under original guidance, they were not permitted to open the packaging for training. Revising the guidance concerning wear time would have permitted troops to practice donning to MOPP Level 3 or 4 before responding to real alerts. They recommended earlier MOPP Level 3 and Level 4 drills.<sup>88</sup>
- The late introduction of additional “air defense conditions” and threat levels (see Threat Level Color Codes above) caused confusion. The staff had never trained on how to react to these warnings. An early briefing on all pertinent alert levels was recommended.<sup>89</sup>
- Some patients arrived without CPE. During Red Alerts and MOPP Level 4 alerts, these patients became frightened, felt abandoned without protective gear, and used garbage bags to cover themselves. The unit recommended sending protective gear with all patients, even those to be medically evacuated from the theater.<sup>90</sup>

The Marines noted that:

- “Training had made going in and out of MOPP instinctive to the Marines.”<sup>91</sup>

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<sup>85</sup> 24th Mechanized Infantry Division Operation Desert Storm After Action Report, subject: *Chemical Defense Equipment Readiness*, 20 May 1991.

<sup>86</sup> XVIII Airborne Corps information paper, subject: *Protective Mask Carrier Repair and Rebuild*, 10 November 90.

<sup>87</sup> 926th Engineer Group, *AAR Comments, Operation Desert Shield/Desert Storm*, forwarded 11 February 1991.

<sup>88</sup> Fleet Hospital Five NAVGRAM, subject: *Lessons Learned, Fleet hospital Five, 01 Jan 91 through 31 Jan 91, JULLS Format*, undated.

<sup>89</sup> Fleet Hospital Five NAVGRAM, subject: *Lessons Learned, Fleet hospital Five, 01 Jan 91 through 31 Jan 91, JULLS Format*, undated.

<sup>90</sup> Fleet Hospital Five NAVGRAM, subject: *Lessons Learned, Fleet hospital Five, 01 Jan 91 through 31 Jan 91, JULLS Format*, undated.

<sup>91</sup> Captain T. F. Manley, *Marine Corps NBC Defense in Southwest Asia*, Marine Corps Research Center Research Paper #92-0009, July 1991, p. 47.

- "The British lightweight suit offered significant advantages over the OG84 in weight and bulk, but not in protection and durability. Weight and bulk reduction were the most important factors to most front line commanders in SWA."<sup>92</sup>

## V. CONCLUSION

During the Gulf War, the use of protective clothing as described in the Mission Oriented Protective Posture (MOPP) procedures proved viable and effective. However, the first extensive use of MOPP in a chemical environment also highlighted some shortcomings. As expected, the primary weakness of increased MOPP posture was the weight and bulk of the equipment that degraded combat performance and made even simple tasks more onerous. Second, the relative short life of chemical protective clothing once it had been exposed could have been a serious problem in an extended hostility, and did bring out concerns about the ability of the supply organizations to keep troops properly outfitted. Finally, the many times in which some individuals assumed higher MOPP protection reinforced the need for NBC discipline by the soldiers, and for regular training with MOPP gear as soldiers would fight in combat.

As a result of these lessons learned in the Gulf War, DoD is addressing these and other MOPP and chemical protective issues. NBC Protection Doctrine has been modified to add flexibility to MOPP, to increase the options available to commanders, and to emphasize the commander's responsibility to make the final balance between potential risks inherent in higher protective levels, mission accomplishment, and survival. Also, the Joint Service Lightweight Integrated Suit Technology is being developed for all services to improve the level of chemical and biological protection provided by a lighter, less bulky suit. Such a suit would reduce heat difficulties, lessen mobility problems, and improve supply sustainability through a longer wear life.

*This information topic remains open. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DoD Persian Gulf Task Force Hot Line at 1-800-472-6719*

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<sup>92</sup> Captain T. F. Manley, *Marine Corps NBC Defense in Southwest Asia*, Marine Corps Research Center Research Paper #92-0009, July 1991, pp. 50

## ***TAB A - Acronym Listing/Glossary***

This TAB provides a listing of acronyms found in this report. Additionally, the Glossary section provides definitions for selected technical terms that are not found in common usage.

### **Acronyms**

AOR	Area of Responsibility
AUIB	Aircrew Uniform Integrated Battlefield
BDO	Battledress Overgarment
CAM	Chemical Agent Monitor
CPE	Chemical Protective Equipment
CPHC	Chemical Protective Helmet Cover
CPOG	Chemical Protective Overgarment
CW	Chemical Weapon
DoD	Department of Defense
HQ	Headquarters
IAD	Investigation and Analysis Directorate
KTO	Kuwait Theater of Operations
MKIII	Mark (Model) Three
MKIV	Mark (Model) Four
MOPP	Mission Oriented Protective Posture
NBC	Nuclear, Biological and Chemical
NCO	Non-Commissioned Officer
OG84	Marine Corps Standard Protective Overgarment
OSAGWI	Office of the Special Assistant for Gulf War Illnesses
US	United States

### **Glossary**

<u>GulfLINK</u>	A World Wide Web site maintained by the Office of the Special Assistant to the Deputy Secretary of Defense for Gulf War Illnesses ( <a href="http://www.gulflink.osd.mil/">http://www.gulflink.osd.mil/</a> ).
<u>M24 Protective Mask</u>	The aircrew NBC protective mask. Protects aircrew personnel both in the aircraft and on the ground. The mask has a hose assembly similar to the M25 mask. As with the M17 Series mask it protects the wearer from all known chemical and biological agents.
<u>M25 Protective Mask</u>	This mask was especially designed for crews of armored vehicles. When used in a tank or other armored vehicle, the mask couples to an on board filter unit. When outside of the vehicle, the wearer inhales through the nose and filter assembly. As with the M17 Series mask it protects the wearer from all known chemical and biological agents.

M40 Protective Mask

The M40 mask was designed with several improvements to the M17 series masks. The face piece of the M40 is made of silicone and covered with a thin layer of butyl rubber. The M40 offers improved comfort and communication.

M17 Series Protective Mask

The M17 series includes the M17, M17A1, and M17A2 protective masks. The mask is made of butyl rubber and protects the eyes, face and respiratory tract from all known chemical and biological agents.

Mil

Unit of measure equal to 1/1000 inch; used in measuring thickness of films or diameter of wire.

Miosis

Constriction of the pupil of the eye caused by abnormal stimulation of the controlling nerves.

SCUD

An intermediate-range missile, originally of Soviet design, capable of delivering large conventional and chemical warheads.

Selective Unmasking

A procedure to confirm negative tests for nerve agent vapor. One or more selected troops unmask for a short time and are observed for evidence of the early onset of toxic effects. The entire unit un.masks if no effects are noted.

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# Case Narrative

## Al Jaber Air Base

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on a series of incidents during the 1<sup>st</sup> Marine Division efforts to capture Al Jaber Air Base, Kuwait. During February 24 through 26, 1991, Marines in the vicinity were advised on several occasions to don chemical protective equipment due to possible chemical agent exposure. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding the capture of Al Jaber. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

Last Update: September 22, 1997

1997265-0000-017

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DOD) established a task force in June 1995 to investigate all possible causes. On November 12, 1996, responsibility for these investigations was assumed by the Investigation and Analysis Directorate (IAD), Office of the Special Assistant for Gulf War Illnesses (OSAGWI), which has continued to investigate incidents at Al Jaber Air Base. Its interim report is contained here. This investigation grew out of Congressional hearings in 1993 which identified Al Jaber as the site of a Fox vehicle chemical weapons alert.

As part of the effort to inform the public about the progress of this effort, DOD is publishing (on the Internet and elsewhere) accounts related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling these accounts. The narrative that follows is such an account.

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## METHODOLOGY

During and after the Gulf War, people reported that they had been exposed to chemical warfare agents. To investigate these incidents and to determine if chemical weapons were used, the DOD developed a methodology for investigation and validation based on work done by the United Nations and the international community where the criteria include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation or human/animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by experts.

While the DOD methodology (Tab D) for investigating chemical incidents is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, our methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

By following our methodology and accumulating anecdotal, documentary, and physical evidence, and by interviewing eyewitnesses and key personnel, and analyzing the results, the investigator can assess the validity of the presence of chemical warfare agents on the battlefield. Because information from various sources may be contradictory, we have developed an assessment scale (Figure 1) ranging from "Definitely" to "Definitely Not" with intermediate assessments of "Likely," "Unlikely," and "Indeterminate." This assessment is tentative, based on facts available as of the date of the report publication; each case is reassessed over time based on new information and feedback.

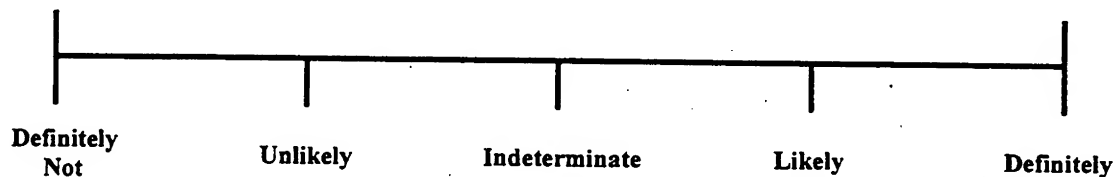


Figure 1. Assessment of Chemical Warfare Agent Presence

The standard for making the assessment is based on common sense: do the available facts lead a reasonable person to conclude that chemical warfare agents were or were not present? When insufficient information is available, the assessment is "Indeterminate" until more evidence can be found.

## SUMMARY

U.S. Marines reported several instances of suspected chemical warfare agent use during combat operations to retake the Kuwaiti Air Base of Al Jaber. Al Jaber is located approximately 50 miles southwest of Kuwait City. From the evening of February 24<sup>th</sup> through the morning of February 26<sup>th</sup> 1991, seven chemical alerts resulted in units near Al Jaber increasing chemical protective posture and donning additional equipment while testing for the presence of chemical agents. The initial source of five of the alerts was traced to observation of friendly artillery smoke that was mis-identified as chemical weapons smoke. The specific source of one alert is still under investigation and will be reported upon in the case narrative about the 11<sup>th</sup> Marines.

The most notable alarm was reported by a Fox vehicle (#5604) in Task Force Ripper, commanded by Gunnery Sergeant George Grass, during the night of February 25, 1991. U.S. armed forces were just integrating the German-made Fox vehicle at the time of Operation Desert Storm and it represented the most sophisticated detection equipment available. As the Fox sat under skies black with the smoke from oil well fires, the MM-1 mass spectrometer alerted for a blister agent (a persistent chemical agent). The alert ceased after several minutes and the source of the alert was not identified.

All of the units in the proximity of each of these alerts initiated the proscribed procedures of taking proper protective posture while testing for chemical agent. The Fox alert as well as the other six alerts were not confirmed by M256A1 Chemical Weapons Detector Kits throughout the area in which Task Force Ripper was deployed. Additionally, no evidence of chemical weapons delivery means, chemical injuries, chemical weapons storage, or actual use anywhere in Kuwait including the Al Jaber area was found during or after the war. Therefore, the assessment that chemical weapons incidents occurred near Al Jaber air base during the ground war is "Unlikely".

## NARRATIVE<sup>1</sup>

### Background

In May 1996<sup>2</sup> and May 1997<sup>3</sup>, Gunnery Sergeant (GySgt) George Grass, testified before the Presidential Advisory Committee Gulf War Veterans' Illnesses about several suspected chemical weapons incidents of which he had personal knowledge of during the Gulf War. GySgt Grass was a Marine Corps nuclear, biological and chemical (NBC) weapons defense specialist and Fox

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<sup>1</sup> An acronym listing/glossary is at Tab A.

<sup>2</sup> Testimony of GySgt George J. Grass, May 1, 1996, Presidential Advisory Committee. [HTML Link](#)

<sup>3</sup> Testimony of GySgt George J. Grass, May 7, 1997, to the Presidential Advisory Committee. [HTML Link](#)

A map of Kuwait and its surrounding regions, including parts of Iraq, Saudi Arabia, and the Persian Gulf. The map features a grid with latitude and longitude coordinates. Key locations and features include:

- KUWAIT CITY**: The capital, marked with a star and labeled.
- Al Khirah**: A location in the north, marked with a star.
- 2d Marine Division AOR**: Area of Responsibility, indicated by a dashed line.
- Ammunition Supply Point**: Located near the center.
- 1st Marine Division AOR**: Area of Responsibility, indicated by a dashed line.
- Al Burgan Oil Field**: Located in the center.
- Al Jaber Air Base**: Marked with a large 'X'.
- Above-Ground Pipeline**: Indicated by a dashed line.
- Mine Field 1** and **Mine Field 2**: Indicated by dashed lines.
- Al Wafrah Oil Field**: Located in the south.
- Al Wafrah**: A location in the south.
- Al Khirah**: A location in the southeast.
- XX**: Two locations marked with 'XX' in a box, one near the coast and one in the south.
- 1**: A location marked with '1' in a box, near the coast.
- PERSIAN GULF**: Labeled on the right side.
- SAUDI ARABIA**: Labeled at the bottom.

Figure 2. - Al Jaber Air Base, Kuwait.

Before the Iraqi Invasion of Kuwait, Al Jaber served as a Kuwaiti military air base. After the Iraqi invasion in August 1990, U.S. intelligence reported that the airfield might be used for the

<sup>7</sup> This same event was referenced in the *Iraqi Chemical Warfare: Analysis of Information Available to DOD (U)*, Chapter 11, Possible Chemical Warfare Agent Release, Department of Defense Intelligence Oversight Committee Report, p. 26. In this report, this event was referenced in Appendix A as three different events: Event 36, 37 and 39. These three events are actually the same singular Fox alert discussed in this narrative.

storage of chemical munitions--mainly because Iraqi ground forces had deployed 30 GHN-45 155mm howitzers and employed the Kuwaiti hardened hangarages for munitions storage.<sup>8</sup> The GHN-45 is a top-of-the-line, Austrian-manufactured artillery piece with a range of 38-40 km., used primarily by Iraqi Republican Guard units.<sup>9</sup> A Defense Intelligence Agency (DIA) paper published before the war notes that, "Iraq regards its 155mm artillery as the weapon of choice for ground force delivery of CW [Chemical Weapons]..."<sup>10</sup> Post-war analysis of UN inspection data shows that the Iraqi 155mm was the sole ground force delivery system of the Mustard chemical weapon agent.<sup>11</sup> Before the war, Iraqi artillery assets consisted of approximately 3600 Soviet Bloc artillery tubes (122mm, 130mm, 152mm) and other North Atlantic Treaty Organization (NATO) artillery tubes (105mm and 155mm). Of these, only 450 were thought to be 155mm.<sup>12</sup>

### Coalition Planning and Actions

During the air war (January 17 through February 23, 1991) coalition aircraft struck Al Jaber several times--attacking bunkers on the air base suspected as chemical weapons storage facilities.<sup>13</sup> Aircraft also dropped anti-personnel mines to impede Iraqi movement in and around the base.<sup>14</sup>

To coalition ground-war planners, the early capture of Al Jaber was a primary goal because of the dense concentration of Iraqi long-range artillery in the vicinity. The 1<sup>st</sup> Marine Division (1<sup>st</sup> MarDiv) Commander considered the Iraqi artillery around the base to be the "nerve center of Iraqi defenses."<sup>15</sup> Consequently, Al Jaber became the Marine Expeditionary Force's (MEF) Objective "Alpha"—a principal liberation goal for elements of the 1<sup>st</sup> MarDiv once they crossed the minefields on the first day of the ground war. The Marines intended to neutralize the Iraqi artillery threat by overrunning Al Jaber and then to use the captured air base as a forward air base for Marine Corps aircraft. It was assumed that Al Jaber would be a crucial staging area for the liberation of Kuwait City.<sup>16</sup>

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<sup>8</sup> Persian Gulf Special Summary, September 1990, CIA. p. 8.

<sup>9</sup> Chemical and Biological Warfare in the Kuwait Theater of Operations: Iraq's Capability and Posturing, Defense Intelligence Agency, undated (but prewar), p. 3

<sup>10</sup> Chemical and Biological Warfare in the Kuwait Theater of Operations: Iraq's Capability and Posturing, Defense Intelligence Agency, undated (but prewar), p. 3.

<sup>11</sup> *The United Nations and the Iraq-Kuwait Conflict*, United Nations, New York, 1996, Document 189, p.656-657.

<sup>12</sup> Intelligence Report, Iraqis Prepositioned Chemical Munitions, ARCENT, March, 1991.

<sup>13</sup> Message from COMUSMARCENT - G-3, 031359Z Feb 91.

<sup>14</sup> Interview with MALS 16 Officer in Charge, Lead Sheet 5279.

<sup>15</sup> 1<sup>st</sup> Marine Division Command Chronology, p. 49.

<sup>16</sup> 1<sup>st</sup> Marine Division Command Chronology, p. 49.



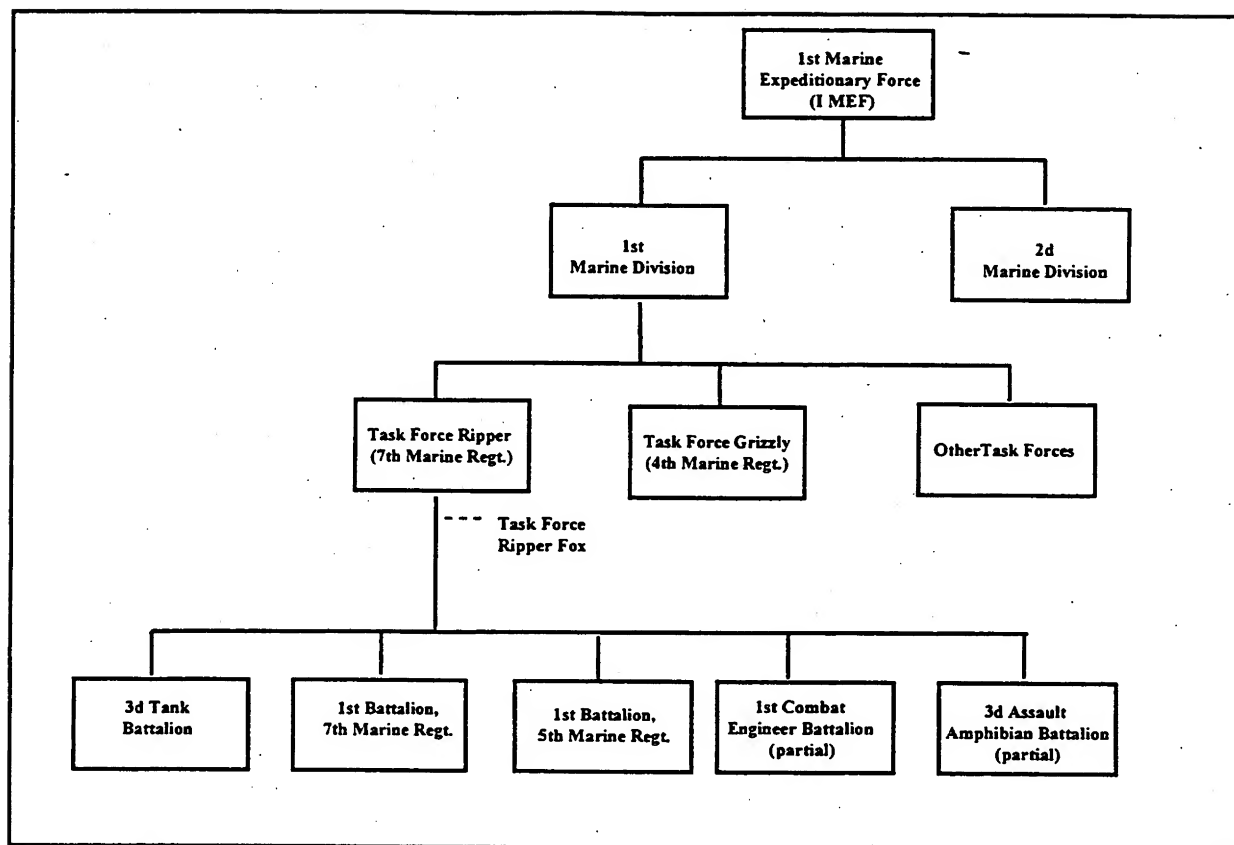


Figure 3. I Marine Expeditionary Force Table of Organization

Most of the units discussed in this narrative were in the 1<sup>st</sup> MarDiv or under this division's operational control. (See Figure 3). For the assault into Kuwait, the 1<sup>st</sup> MarDiv was organized into Task Forces. Two of these, Task Force Ripper and Task Force Grizzly, played roles in capturing Al Jaber air base from Iraqi forces. Task Force Ripper consisted of the three battalions of the 7<sup>th</sup> Marine Regiment. These units were the 3<sup>rd</sup> Tank Battalion, the 1st Battalion of the 5<sup>th</sup> Marine Regiment (1/5), and the 1st Battalion of the 7<sup>th</sup> Marine Regiment (1/7). Task Force Ripper was augmented with forces from the 1<sup>st</sup> Combat Engineer Battalion, the 3<sup>rd</sup> Assault Amphibian Battalion, and the 3<sup>rd</sup> Battalion of the 11<sup>th</sup> Marine Regiment (3/11), which provided artillery support. The 1<sup>st</sup> MarDiv also gave Task Force Ripper one of the four Fox NBC Detection vehicles attached to the division.<sup>17</sup>

During the course of combat on the first day of the ground war, Iraqi forces set fire to the nearby Al Burqan oil fields. The heavy black smoke from these fires sharply reduced visibility during the combat operations to secure Al Jaber. Despite crossing a second mine field, Iraqi ground force resistance, artillery and the smoke, Task Force Ripper surrounded the air base by 1800 hours on February 24<sup>th</sup> (the first day of the ground war). Iraqi forces, however, still held the base.<sup>18</sup> Because of the reduced visibility, operations to take the base were postponed until the

<sup>17</sup> Interview with Task Force Ripper NBC Officer, Lead sheet 5325.

<sup>18</sup> 1<sup>st</sup> Marine Division Command Chronology, p. 80.

following day, February 25.<sup>19</sup> A number of Iraqi soldiers surrendered to Task Force Ripper units during the afternoon and evening of February 24<sup>th</sup>. These prisoners revealed that only conventional munitions—not chemical warfare rounds—were stored in Al Jaber's bunkers.<sup>20</sup>

### **Five Chemical Alerts on the Night of 24/25 February**

The night of February 24-25 was tense for the Marines encircling Al Jaber. Task Force Ripper troops had been warned that Iraq might use chemical weapons, and this knowledge, combined with the expectation of a pitched battle the next day (or sooner), set nerves on edge.<sup>21</sup> Interviews conducted for this investigation indicate that several units around Al Jaber donned chemical protective equipment to a Mission Oriented Protective Posture level 4 (MOPP-4<sup>22</sup>) five times between 2000 hours on Feb. 24 and 0200 hours on the Feb. 25.<sup>23</sup> However, no records of these alerts appear in any of the unit chronologies. None of those interviewed remember any alerts to go to MOPP-4 being broadcast over any of the radio nets. Those interviewed about these events remember being told of a "gas" alert verbally.<sup>24</sup>

The 1<sup>st</sup> MarDiv NBC NCO stated that atmospheric conditions that night caused the smoke from outgoing artillery to hug the ground rather than dissipate. On several occasions, Marines mistook this artillery smoke for Iraqi chemical attacks and this was erroneously reported.<sup>25</sup> However, they took no chances and followed normal procedures for confirming a chemical alert while investigating the cause. 1<sup>st</sup> MarDiv Headquarters Forward Command Post—sometimes called the "Bravo" CP—was located outside the base (See Figure 4) and the NBC staff performed tests with their M256A1 chemical warfare agent detector kit after each "gas" alert.<sup>26</sup> Each of the five M256 tests produced no positive results—indicating no chemical agents were present. Following standard procedure, a few individuals were selected to remove their gas masks. These men were then observed for several minutes to see if they experienced any chemical warfare agent exposure symptoms. When they did not exhibit symptoms, a general "all clear" was sounded, returning all the Marines to MOPP-2.<sup>27</sup>

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<sup>19</sup> 1<sup>st</sup> Marine Division Command Chronology, p. 97-98.

<sup>20</sup> 7<sup>th</sup> Marines Log. Log entry times for the Iraqi prisoner disclosures: 1643 and 1733 hours.

<sup>21</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325.

<sup>22</sup> Described in the glossary.

<sup>23</sup> Interview with 1<sup>st</sup> MarDiv NBC Staff, Lead Sheet 5299.

<sup>24</sup> Interview with members of the 245<sup>th</sup> Psychological Operations (PSYOPS) Detachment, U.S. Army, Lead sheets 5156 and 5181.

<sup>25</sup> Interview with 1<sup>st</sup> MarDiv NBC Staff, Lead Sheet 5299.

<sup>26</sup> Description of M256A1 in Glossary.

<sup>27</sup> Interview with 1<sup>st</sup> MarDiv NBC Staff and Executive Officer, Lead Sheets 5299 and 5357.

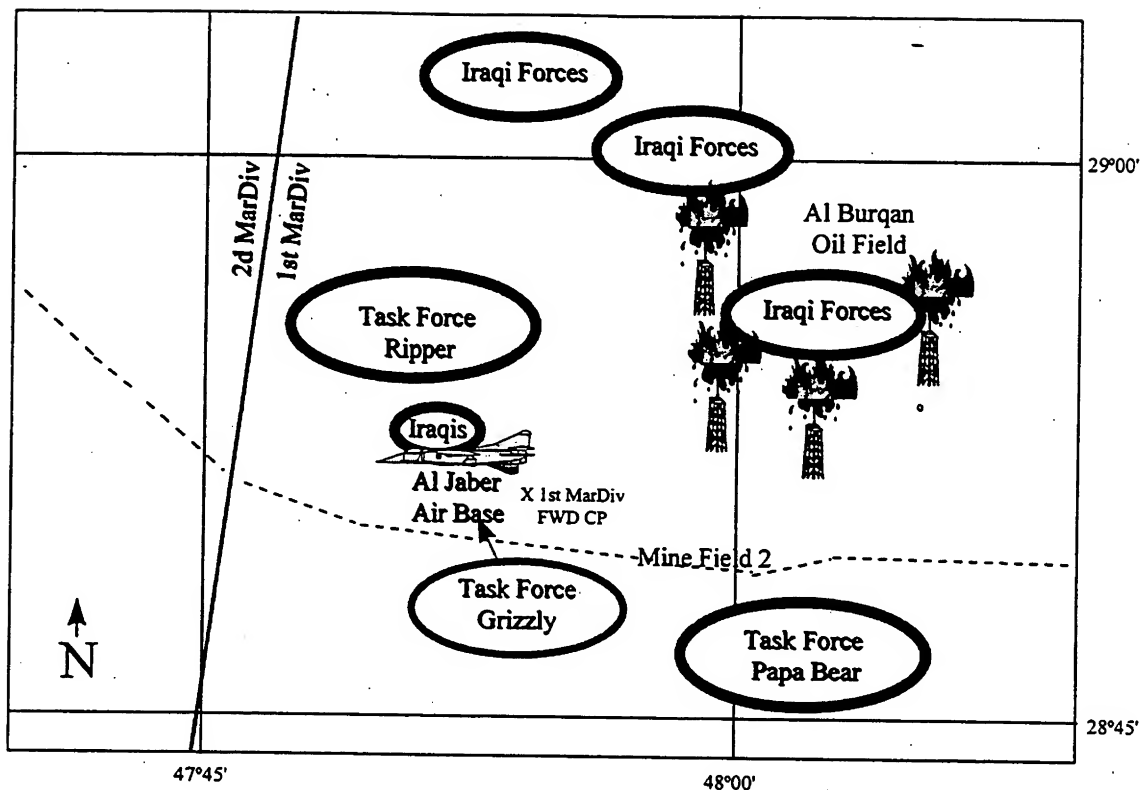


Figure 4. Unit deployment around Al Jaber, Night of Feb. 24/25, 1991.<sup>28</sup>

Although some of those involved believed there was a Fox detection vehicle at Al Jaber, none of the 1<sup>st</sup> MarDiv's Fox vehicles were present. The four Fox Vehicles were deployed as follows: Task Force Ripper, Task Force Papa Bear, and two with 1<sup>st</sup> MarDiv Mobile Command Post. Only the Task Force Ripper Fox was close to the air base - probably within five miles, but they reported no alerts on this night.<sup>29</sup>

Task Force Grizzly captured over 1000 Iraqi soldiers during this first day of the ground war and they were being held just outside the gates of Al Jaber. Few of these prisoners had chemical protective equipment, and following the five alarms, none appeared to have suffered any ill effects that would be reflective of chemical exposure. Task Force Grizzly Marines observed no chemical warfare agent exposure effects among the prisoners. Similarly, several Marines reported sleeping through some of the alarms without donning their masks and suffered no ill effects.<sup>30</sup>

<sup>28</sup> 1<sup>st</sup> Marine Division Command Chronology, p. 89.

<sup>29</sup> Interview with Task Force Ripper NBC Officer, Lead sheet 5325.

<sup>30</sup> Interview with Task Force Grizzly Commander, Lead Sheet 5354.

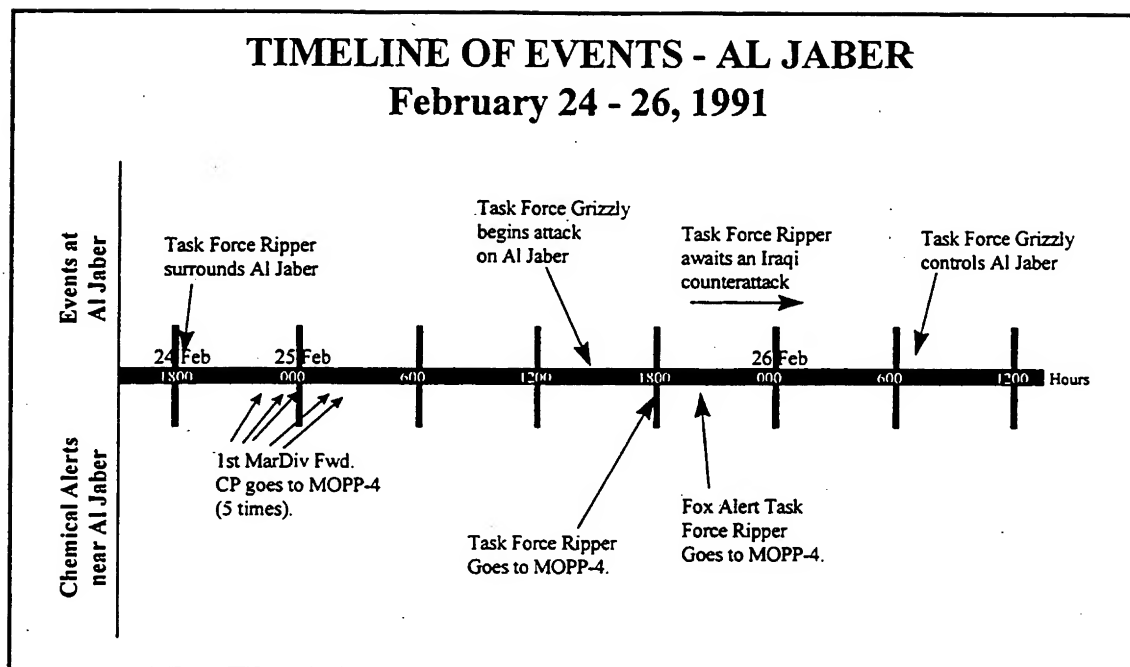


Figure 5. Timeline of Events for February 24-26, 1991.

### Continued Attempts to Take Al Jaber

Task Force Grizzly was given the task of clearing the enemy from the base on the 25th. The attack began at 1600 hours and, by the morning of February 26, (Figure 5) Task Force Grizzly occupied or controlled most of the base. Most of the Iraqi defenders gave up, but resistance continued on February 25, particularly from long-range artillery north of the base. The ensuing artillery battle between the Marines and the Iraqi III Corps produced more Coalition force casualties (none chemical) than any other single engagement of the war. This heightened the tension and combined with the previous intelligence about possible chemical attacks added to cause for concern over Iraqi use of chemicals. At one point, the Task Force Grizzly Commander requested permission to use riot control agents ("tear gas") to subdue the remaining base defenders, but this request was denied by higher authorities out of concern that the Iraqis might retaliate with chemical weapons.<sup>31</sup>

As the fighting continued, Task Force Ripper heard from the Iraqi prisoners that an Iraqi counterattack would come "out of the flames."<sup>32</sup> The Task Force Ripper command thought this meant that a counterattack would be coming from out of the smoke of the burning oil fields. Task Force Ripper established a defensive mobile screening force north of the air base to prepare for the anticipated counterattack. The Iraqi attack never developed, but Marines were still anticipating an attack when a chemical alert occurred.<sup>33</sup>

<sup>31</sup> 1<sup>st</sup> Marine Division Command Chronology, p. 94.

<sup>32</sup> 1<sup>st</sup> Marine Division Command Chronology, p. 90.

<sup>33</sup> 1<sup>st</sup> Marine Division Command Chronology, p. 90.

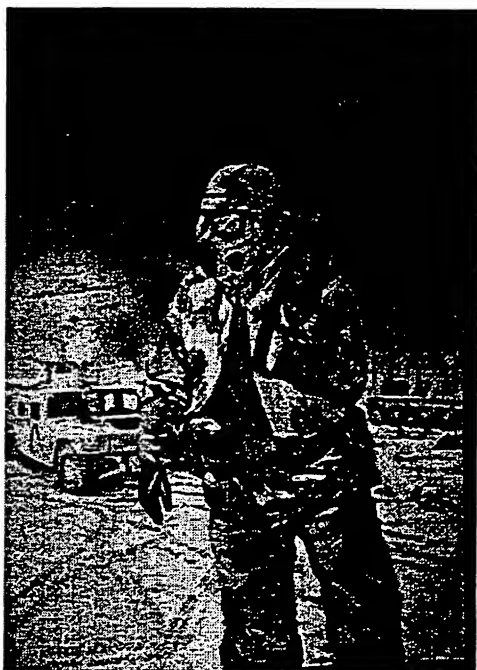


Figure 6. "Ripper" in MOPP-4<sup>36</sup>

### The 1800 Hours Alert on February 25th

At 1800 hours, Task Force Ripper was alerted to a possible gas attack and went to MOPP-4 (Figure 6). The Task Force Ripper NBC Officer was careful to record "went to MOPP-4" and not "gas attack," as he had no confirmation of a chemical weapons attack. It is possible that the initial radio announcements declared a gas attack rather than a change in proscribed protective measures.<sup>34</sup> Consider, for instance, the way the 1<sup>st</sup> Combat Engineers Battalion reported the same alert:

1800 - Flash! Flash! Gas! Gas! 3d Tk Bn log train reports they have been gassed. TF Ripper goes to MOPP 4.  
1830 - All clear<sup>35</sup>

The Task Force Ripper NBC Officer reemphasized reporting discipline throughout the Task Force, but for the first several days of the ground conflict, many suspected chemical attacks were reported as "confirmed attacks"

over the radio nets. This left personnel in many units under the impression that actual chemical attacks had occurred and had been confirmed. Clearly, this is not the case as this was only a suspected attack and as will be described, cannot be confirmed by 3d Tank Battalion or anyone else.

The alert at 1800 hours was investigated as one of the seven events at Al Jaber, but it is currently unclear who the source of the alert was and where it occurred on the battlefield. Although the log quoted from above attributes it to the 3d Tank Battalion, no mention of the incident appears in the 3<sup>rd</sup> Tank Battalion's logs.<sup>37</sup> Interviews of the 3<sup>d</sup> Tank Battalion Commander, the resupply officer (S-4), and NBC officer also failed to shed any light on the report. In fact, the NBC officer was quite emphatic, stating that the attribution of this report to 3<sup>d</sup> Tanks was incorrect.<sup>38</sup> The Task Force Ripper NBC Officer remembers the alert coming from the resupply convoy in the rear, approximately 20 miles behind the main body of the Task Force located at Al Jaber.<sup>39</sup> Investigators have been unable to locate anyone who recalls the specifics of this alert.<sup>40</sup>

<sup>34</sup> 7<sup>th</sup> Marines Logs.

<sup>35</sup> Command Chronology of the 1<sup>st</sup> Combat Engineer Battalion.

<sup>36</sup> "Ripper" goes to MOPP -4, with permission of the US Marine Corps Historical Center, Artist Col Avery

<sup>37</sup> 3<sup>rd</sup> Tank Logs

<sup>38</sup> Interviews with the 3<sup>rd</sup> Tank Battalion Commander, logistician (S-4) and NBC officer, Lead Sheets 3873, 5358, 5273.

<sup>39</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325.

<sup>40</sup> Attempts to discuss this matter with those in the resupply train of Task Force Ripper have not resulted in additional knowledge of this alert. Interviews with Task Force Ripper NBC Staff and 3<sup>rd</sup> Tank S-4, lead sheets 5337, 5273.

Nevertheless, the 1800 hours alert was taken seriously and standard operating procedures were initiated: All affected units went to MOPP-4 and NBC personnel began checking for chemical agents. The Task Force Ripper NBC Officer recalls establishing an NBC "picket line" of two or three Marines several hundred yards upwind of the Task Force Command Post. These Marines used M256 kits to test the air for chemical agents. The tests took approximately 23 minutes to perform. All local monitoring by subordinate units resulted in negative tests—no agents detected. At that point (1830 hours), Task Force Ripper returned to MOPP-2<sup>41</sup> (Figure 7).

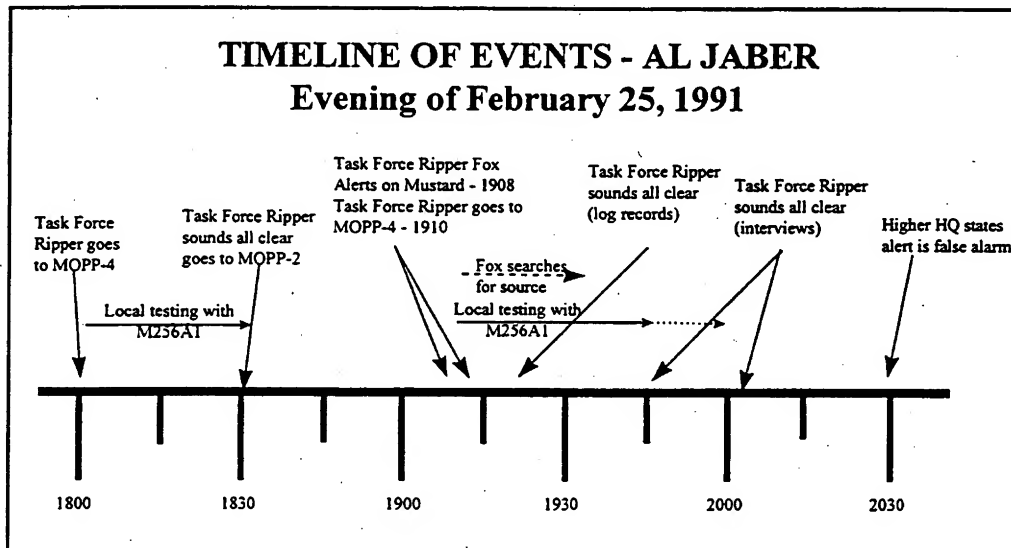


Figure 7. Timeline of Events—Fox Alert

## The Fox Alert

### *The Initial Alert*

Less than an hour later, at 1908 hours on the 25th, the Fox vehicle<sup>42</sup> (Figure 8) attached to Task Force Ripper and operating north of Al Jaber air base alerted to a blister agent. At the time of the alert, wind conditions were 10-15 mph or higher, with gusts reaching 30-40 mph. GySgt Grass, the Fox Commander, and the driver were on the roof of the vehicle in MOPP-2. The MM-1 (mass spectrometer) operator and the "wheel-man" or alternate MM-1 operator were inside the vehicle. The Fox, still under the control of Task Force Ripper was deployed with 3<sup>rd</sup> Tanks in a stationary position approximately 1 kilometer northwest of the air base, awaiting the possible Iraqi counterattack.<sup>43</sup>

<sup>41</sup> Interview with Task Force Ripper NBC Officer and 3<sup>rd</sup> Tank Battalion NBC Officer, Lead Sheets 5325, 5358.

<sup>42</sup> For a better understanding of the Fox NBC Reconnaissance Vehicle, see the Fox Information Paper.

<sup>43</sup> Interviews with Fox 5604 Crew, Lead Sheets 5359, 5353, 5391 and Interview with GySgt Grass, February 1997, p.11.

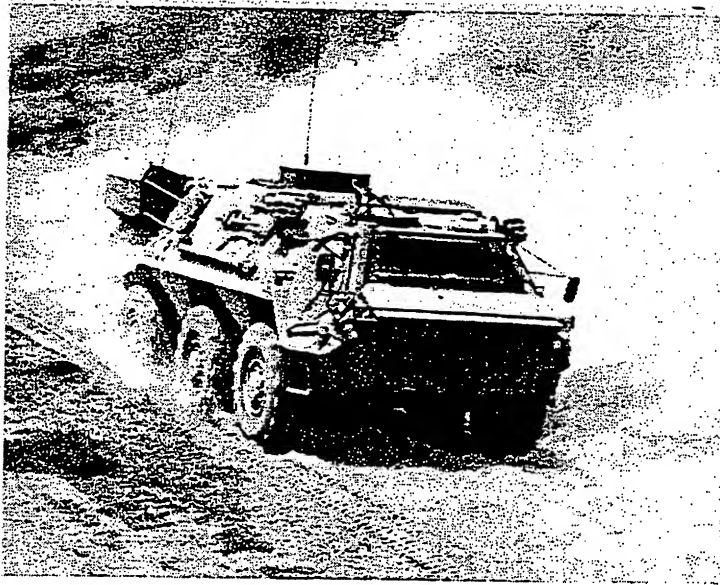


Figure 8. A Fox NBC Reconnaissance Vehicle in Desert Storm Camouflage.

Smoke from the oil well fires obscured everything, limiting visibility to a few feet. Some reports state that the flashes of weapons fire could be observed through the smoke. The Fox driver recalls an artillery round landing upwind approximately four kilometers away. Five to six minutes passed and then the blister alert sounded.<sup>44</sup> GySgt Grass states that there was fighting but no shelling in the area.<sup>45</sup>

### *Fox Capabilities*

The primary chemical agent detector on the Fox vehicle is the MM-1 mass spectrometer. The MM-1 detects chemical agents by analyzing the ionic activity of a sample collected through a retractable probe. The probe can collect samples by "sniffing" the surrounding air (the "Air/Hi" method) or by taking them from a silicone wheel which is lifted from the ground to the probe (the "Surface/Lo" method). At the time of the alert at Al Jaber, the Fox was employing the least sensitive "Air-Hi" method. For example, this Fox method is more than 100 times less sensitive than an M256 kit in detecting nerve agent (Table 1). In the "Air-Hi" method, the MM-1 is performing a "quick-look" analysis of air samples, looking for ions that resemble chemical agents.

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<sup>44</sup> Interview with Fox 5604 driver, Lead Sheets 5353, 5359.

<sup>45</sup> Interview with GySgt Grass, Feb. 1997, p.12.

Item	Agents - Type	Sensitivity	Response Time
M8A1 Alarm	G, V - Nerve	0.1-0.2 mg/m <sup>3</sup>	<=2 min
M256A1 Kit	G - Nerve	0.005 mg/m <sup>3</sup>	15 min
	V - Nerve	0.02 mg/m <sup>3</sup>	15 min
	H - Blister	2 mg/m <sup>3</sup>	15 min
	L - Blister	9 mg/m <sup>3</sup>	15 min
	CX - Blister	3 mg/m <sup>3</sup>	15 min
	CK - Blood	8 mg/m <sup>3</sup>	15 min
	AC - Blood	9 mg/m <sup>3</sup>	25 min
CAM	GA, GB, VX, HD, HN	<= 0.1 mg/m <sup>3</sup>	<=1 min
MM-1 <sup>46</sup>	GB <sup>47</sup> - Nerve	62 mg/m <sup>3</sup>	<=45 sec
	CK - Blood	46 mg/m <sup>3</sup>	
	CG - Choking	115 mg/m <sup>3</sup>	

Table 1. Vapor Chemical Agent Detector Characteristics<sup>48</sup>

If the MM-1 alerts to a possible chemical agent, there is an audible alarm. A full spectrum analysis must then be performed to confirm or deny the presence of chemical agents. The preferred method for performing a full spectrum is the "Surface-Lo" method: The MM-1 probe is extended to the ground (usually to a suspected liquid chemical agent) and the operating temperature of the MM-1 is lowered. Only by performing a full spectrum can an alert be confirmed or denied solely by the Fox vehicle. A "tape," which provides details of the MM-1's findings, can be printed as a permanent record of the initial alert and the full spectrum.

During the Gulf War, the Fox vehicle was manned by a crew of four—the Fox vehicle commander, a driver, an MM-1 operator and a wheel operator. The wheel operator uses levers inside the vehicle to lift the silicone wheels from the ground to the probe for sampling. The driver and commander sit in the front of the vehicle, while the MM-1 and wheel operators sit in the rear. The two areas are connected by a narrow crawl-through.<sup>49</sup>

According to the Fox "wheel man", he and the MM-1 operator were inside the Fox, sampling the air in the "Air-Hi" method, when they saw the MM-1 screen flash an alert for an airborne chemical warfare agent. They called to the driver and GySgt Grass outside on the roof of the vehicle to get inside and close the hatches so the protective overpressure system could be engaged. The Fox crew noted no characteristic chemical agents odors and reported no symptoms or illness.<sup>50</sup>

<sup>46</sup> Because the minimum detectable amount is calculated from the background and backgrounds vary—dependent on environmental and atmospheric conditions—the minimum detectable amounts will vary. The sensitivities listed in Table 2 are relevant only for the specific conditions they were calculated from.

<sup>47</sup> At this level unprotected personnel would experience moderate to severe symptoms from Sarin before the MM-1 would alert.

<sup>48</sup> Report of the Defense Science Board Task Force on Persian Gulf War Health Effects; June 1994 Table 18.

<sup>49</sup> For more information on the Fox vehicle, please refer to the Fox NBC Reconnaissance Vehicle Information Paper - HTML Link to Fox Paper.

<sup>50</sup> Interviews with Fox 5604 Crew, Lead Sheets 5359, 5353, 5391, 5336 and Interview with GySgt Grass, Feb. 1997, p.19.



Accordingly, the MM-1 operator started the full spectrum analysis. Either during (or immediately after) the full-spectrum procedure, the alarm ceased and the MM-1 returned to "normal" readings. There is a difference in opinion of the crew as GySgt Grass and the wheel man report that a spectrum confirmed chemical warfare agent presence. The driver states that as the MM-1 operator changed methods, the alert ceased, precluding a spectrum being performed.<sup>51</sup>

### *Reporting the Alert*

While the MM-1 operator performed his analysis, GySgt Grass reported the blister alert to Task Force Ripper's NBC Officer. The 3<sup>rd</sup> Tanks NBC Officer was also notified. GySgt Grass remains certain that he reported a Mustard gas detection.<sup>52</sup> None of the other Fox crew members interviewed remember for certain what type of chemical agent was detected.<sup>53</sup> The Task Force Ripper NBC Officer thought it was a Lewisite detection and states that a mistake in the reporting was probably his, since GySgt Grass was an actual witness.<sup>54</sup>

When the Task Force Ripper NBC Officer was notified of the alert, he immediately attempted to determine the wind speed and direction to alert units downwind of the Fox. For some reason, he was unable to ascertain any wind speed or direction so as a precaution he placed the entire Task Force at MOPP-4 and ordered each battalion to begin local testing with M256 detector kits.<sup>55</sup>

Without stating that a possible gas attack had occurred, the Task Force Ripper NBC Officer directed the Task Force Ripper Operations Officer (S3) to announce over the radio that that all units go to MOPP-4. He did not want to cause panic, but he wanted to make sure that protective measures were taken. Regardless of his concern, the message left many listeners with the impression that an actual gas attack occurred at 1910 hours.<sup>56</sup>

Each unit within Task Force Ripper reported the details of the blister alert differently. (The log reports of these units can be found in Tab E.) Oddly, although the Fox was deployed with 3<sup>rd</sup> Tanks, this battalion does not have a log entry that notes this alert at all.<sup>57</sup> Many of the alerts designate Lewisite, not Mustard; this may derive from the discrepancy between Grass's and the Task Force Ripper NBC Officer's reports.

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<sup>51</sup> Interviews with Fox 5604 Crew, Lead Sheets 5359, 5353, 5391, 5336 and Interview with GySgt Grass, Feb. 1997, p.19. Driver Statement to 1994 Marine Corps Investigation., p. 3 of Lead Sheet 5359.

<sup>52</sup> Interview with GySgt Grass, Feb. 1997, p.21. GySgt Grass says he reported the alert to the 3<sup>rd</sup> Tank NBC Officer, but both the 3<sup>rd</sup> Tank and Ripper NBC Officers remember him reporting to Ripper while 3<sup>rd</sup> Tanks NBC Officer was monitoring. Lead Sheets 5325, 5358.

<sup>53</sup> Interview with Fox 5604 Crew, Lead Sheets 5359, 5353, 5391, 5336.

<sup>54</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325.

<sup>55</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325.

<sup>56</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325.

<sup>57</sup> 3rd Tank Bn Logs

### *Attempts at Confirmation*

Most of the unit logs report "all clear" within 10-12 minutes of the initial report. This is difficult to understand since an M256 Test Kit takes 15 minutes to test for nerve and blister agents and up to 25 minutes to test for blood agents.<sup>58</sup> (Iraq had no blood agents.) Both Task Force Ripper's and 3<sup>rd</sup> Tanks' NBC Officers are sure that individual units performed M256 tests after the Fox alert to completion. Neither of these men can explain how the "all clear" could have been sounded 10-12 minutes after MOPP-4 had been ordered. They are sure, however, that the tests were fully performed, that all proved negative, and that selective unmasking was performed before the unit returned to MOPP-2. At Task Force Ripper Headquarters, the NBC Officer ordered two M256 tests to be performed 10 minutes apart. When both tested negative for chemical warfare agents and selective unmasking produced no symptoms, he ordered a return to MOPP-2.<sup>59</sup> At the earliest, this would have been at 1935 hours. The 3<sup>rd</sup> Tanks logs show unmasking beginning at 1959 hours, presumably after this alert.<sup>60</sup>

While all the units of Task Force Ripper were testing with M256 kits, the Fox crew attempted to locate the source of the original alert. Under normal circumstances, the Fox would have searched the surrounding area, attempting to find additional evidence of any chemical agent contamination (NBC units are trained to locate and isolate a contaminated area, then detour troops and traffic around it until decontamination or normal dissipation renders the area safe for normal operations.) Mustard and Lewisite are both persistent agents—usually existing in a liquid form—so the Fox crew hoped this search would identify the source. A number of circumstances limited this search. The smoke from the burning oil fields made identification of friendly and enemy vehicles very difficult. The Fox looks like a Soviet-made, Iraqi Army BTR-60 Armored Personnel Carrier and there were concerns that Marines might mistake it for an enemy vehicle. To avoid this possibility, the Task Force Ripper Fox vehicle was given a security escort during most of the ground war. At this point in the ground combat action at Al Jaber, the security detail left the Fox to engage in a firefight. Consequently, the Fox was limited in the area it could safely search and the source of the alert was not found.<sup>61</sup>

Mustard, the agent alerted on in the Fox alert, is classified as a persistent agent and would therefore probably leave a detectable residue for some time after an attack. Table 2 displays some of the characteristics of chemical warfare agents. Mustard (HD and HN) and Lewisite (L) are both blister agents that are used in liquid form and have similar characteristics.<sup>62</sup> A drop of

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<sup>58</sup> Some agents types such as nerve and blister will be detected within 15 minutes, but to ensure no CWA (including blood agent types) are present, the test should be run to its conclusion. *The Report of the Defense Science Board Task Force on Persian Gulf War Health Effects*, June, 1994, p. 35.

<sup>59</sup> Interview with Task Force Ripper and 3<sup>rd</sup> Tank NBC Officers, Lead Sheets 5325, 5358.

<sup>60</sup> 3<sup>rd</sup> Tank Bn Logs

<sup>61</sup> Interview with GySgt Grass, Feb. 1997, p. 22-25.

<sup>62</sup> There are pre-war reports that Iraq possessed "Dusty Mustard"—a powder form of Mustard—but this CWA was not found by UNSCOM after the war. *The United Nations and the Iraq-Kuwait Conflict*, United Nations, New York, 1996, Document 189, p.656-657.

the liquid on exposed skin will cause large blisters to form. Inhalation of tiny droplets will cause scarring on the lungs. Blister agents on the battlefield would normally be found in pools of liquid agent, noticeable for days to weeks after an attack. Additionally, blister agents can cause casualties for several days after an attack.

Types of Agents	Symbol	Persistence		Rate of Action	Entrance	
		Summer	Winter		Vapor Aerosol	Liquid
Nerve	G-Agents	10 min to 24 hrs	2 hr to 3 days	Very Quick	Eyes, Lungs	Eyes, Skin, Mouth
	V-Agents	2 days to 1 week	2 days to wks	Quick	Eyes, Lungs	Eyes, Skin, Mouth
Choking	CG, DP	1 to 10 min	10 min to 1 hr	Immediate	Lungs	Eyes
Blister	HD, HN	3 days to 1 wk	Wks	Slow	Eyes, Skin, Lungs	Eyes
	L	1 to 3 days	Wks	Quick	Eyes, Skin, Lungs	Eyes, Skin, Mouth
	CX	Days	Days	Very Quick	Lungs	
Blood	AC, CK	1 to 10 min	10 min to 1 hr	Very Quick	Lungs	Eyes, Injured Skin

Table 2. Chemical Warfare Agent Symptoms and Characteristics.<sup>63</sup>

### *Analysis of the Fox Tape*

The Task Force Ripper Fox printed either an initial alert tape or a full spectrum tape.<sup>64</sup> It is possible to print a tape of an initial alert, before a full spectrum analysis is performed. Only a full spectrum analysis will confirm an initial alert. It is unclear if a full spectrum analysis was performed and which type of tape was printed.

A difference of opinion exists about the handling of the tape. GySgt Grass recalls talking via radio to the 1<sup>st</sup> MarDiv NBC Officer about this alert. After the conversation, Grass kept the tape until the night of February 28, when he gave this tape and several others to the 1<sup>st</sup> MarDiv NBC Officer.<sup>65</sup> The Task Force Ripper and 1<sup>st</sup> MarDiv NBC Officers both recall that the tape was forwarded by GySgt Grass to the Ripper NBC Officer who personally showed the tape to the 1st MarDiv NBC Officer during a meeting sometime around 0830 hours on February 26.<sup>66</sup>

Several hours earlier, at around 0400 hours, the 1st MarDiv NBC Officer viewed a tape from another Fox. Although originally believed to be a chemical alert the alert on this tape was subsequently determined to be a "false positive" caused by the burning Al Burqan oil field.<sup>67</sup> With this false positive in mind, the 1st MarDiv NBC Officer examined the Al Jaber tape. There

<sup>63</sup> FM 3-100, NBC Operations, Department of the Army, Washington, D.C., 17 Sept. 1985.

<sup>64</sup> See also the Fox Vehicle Issue Paper for further discussion and examples of Fox tapes. HTML Link

<sup>65</sup> Interview with GySgt Grass, Feb. 1997, p. 29. See also the ASP/Orchard Case. HTML Link

<sup>66</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325.

<sup>67</sup> Interview with 1st MarDiv NBC Officer and Fox MM-1 operator, Lead Sheets 5274 and 5310.

was no other evidence to substantiate the alert, so the 1<sup>st</sup> MarDiv NBC Officer concluded that the Al Jaber alert was also caused by oil smoke.<sup>68</sup>

At the time of the Gulf War, the Marine Corps had not established procedures for analysis and archiving of Fox tapes. Unfortunately, the whereabouts of the Al Jaber Fox tape is unknown. The 1<sup>st</sup> MarDiv NBC Officer either destroyed the tape on February 26<sup>th</sup> or filed it with records that were subsequently destroyed. He considered the case closed and saw no need to keep this tape.<sup>69</sup>

GySgt Grass and the Task Force Ripper NBC Officer don't agree with the 1<sup>st</sup> MarDiv NBC Officer's oil smoke assessment. Grass has stated that the oil fires were constantly being detected at a low level. He had assigned the label "Unknown 1" to oil fires for detection by the spectrometer, and he clearly remembers this alert being different than the normal screen image of oil fire ion activity. He also states that this alert was not like the readings of exhaust smoke that produce alerts of "Fat, Oil, Wax."<sup>70</sup> The Task Force Ripper NBC Officer agreed with GySgt Grass's assessment due to Grass's expertise with the Fox vehicle.<sup>71</sup>

### *Other Relevant Log Entries*

The 3<sup>rd</sup> Battalion, 11<sup>th</sup> Marine Regiment (3/11) Command Chronology reports that at 2030 hours on the 25<sup>th</sup>, the 1<sup>st</sup> MarDiv reported that the blister agent was a false alarm. According the Task Force Ripper NBC Officer, it was the unit above, the I MEF (the 1<sup>st</sup> Marine Expeditionary Force Headquarters), not the division, that made this pronouncement. The Task Force Ripper and the 1<sup>st</sup> MarDiv NBC Officers wondered how higher headquarters personnel could make a determination from the rear area. It did not matter though, for by 2030 hours the Task Force Ripper NBC Officer had already decided that if there had been a valid detection, it was no longer detectable and there was therefore no need to stay in MOPP-4.<sup>72</sup>

One additional record of possible chemical warfare agents came from the 1<sup>st</sup> Battalion of the 12<sup>th</sup> Marine Regiment (1/12), assigned to the 11<sup>th</sup> Marine Regiment. An entry in the 1/12 command chronology recorded that on February 26<sup>th</sup> at 0220 hours, the Task Force Ripper Fox vehicle reported lewisite vapor.<sup>73</sup> However, the Task Force Ripper NBC Officer states that there was only one Task Force Ripper Fox alert during the ground war and that was at 1908 hours on February 25<sup>th</sup>.<sup>74</sup> This is consistent with all the testimony of GySgt Grass who never reported any detection of lewisite and only alerted to Mustard near Al Jaber. This incident will be covered in the case on the 11<sup>th</sup> Marines.

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<sup>68</sup> Interview with 1st MarDiv NBC Officer, Lead Sheet 5274.

<sup>69</sup> Interview with 1st MarDiv NBC Officer, Lead Sheet 5274.

<sup>70</sup> Interview with GySgt Grass, Feb. 1997, p. 28.

<sup>71</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325

<sup>72</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325.

<sup>73</sup> 1/12 Command Chronology

<sup>74</sup> Interview with Task Force Ripper NBC Officer, Lead Sheet 5325.

## Cleanup of Al Jaber

After Al Jaber was cleared of Iraqi forces by Task Force Grizzly on February 26<sup>th</sup>, the Marines began to ready the base as a forward base for Marine aircraft. Task Force Grizzly maintained the base and the perimeter until March 3<sup>rd</sup> (Figure 9). The commander of Task Force Grizzly set up his headquarters in a former air-to-air missile ammunition storage point. According to the commander, the Marines of Task Force Grizzly reported no signs of chemical weapons storage or chemical warfare symptoms from use.<sup>75</sup>

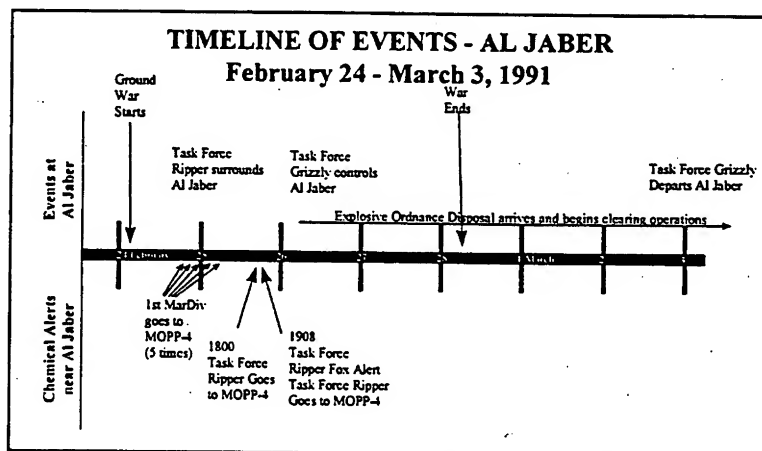


Figure 9. Timeline of Events, Feb. 24 - March 3, 1991.

In order to prepare the base for offensive actions, Marine Explosive Ordnance Disposal (EOD) teams were sent to the base to clear away hazardous weapons. The Marine Air Logistics Squadron 16 (MALS 16) EOD Team arrived at Al Jaber by helicopter early on February 26<sup>th</sup>. Their primary mission was to collect and destroy unexploded munitions on the runways. Most of the munitions they encountered were "area denial" mines and bomblets dropped on the base by Coalition aircraft during the air war or Kuwaiti Air Force munitions left from before the war. The EOD team also found Iraqi munitions. After inspecting and testing these munitions (with M-8 chemical detection paper<sup>76</sup> where appropriate), none were found to be chemical and all were subsequently destroyed.<sup>77</sup> Although the EOD team was concerned primarily with preparing the air base for operations, the commander stated that they were "ammunition curious" and looked into everything they could. The MALS 16 team left the air base on March 3<sup>rd</sup>.<sup>78</sup>

In addition to Task Force Grizzly and MALS 16, the 1<sup>st</sup> and 2<sup>nd</sup> EOD Platoons of the 7<sup>th</sup> Engineer Detachment performed cleanup operations on the base. They went through all storage areas looking for anything suspicious such as leaking munitions or weapons that might have chemical agent filler plugs. Most of the ammunition in these facilities was Kuwaiti Air Force ammunition

<sup>75</sup> Interview with Grizzly Commander, Lead Sheet 5354.

<sup>76</sup> Description of the M-8 Detection Paper found in the Glossary.

<sup>77</sup> *EOD Situation Report for the period 23 February 1991 through 31 March 1991*, MALS-16, 10 April 1991, enclosure 1 and enclosure 3.

<sup>78</sup> Interview with MALS-16 Officer in Charge, Lead Sheet 5279.

of various manufacture. The 1<sup>st</sup> Platoon worked outside the base, while the 2<sup>nd</sup> Platoon cleared inside the base. The 2<sup>nd</sup> Platoon left the area on March 1st and the 1<sup>st</sup> Platoon then took over the base and cleared munitions found in the area through April. Neither the 1<sup>st</sup> nor the 2<sup>nd</sup> Platoons report finding any chemical weapons (persistent or non-persistent) or evidence of persistent chemical weapons use. Additionally, no one recalls finding any Iraqi 155mm shells—later confirmed as a the primary ground delivery system of Mustard weapons.<sup>79</sup> Some of the unit files were routinely destroyed on a two year cycle, so records of all destroyed munitions are not available.<sup>80</sup>

### **Analysis of the Incidents**

The focus of this section will be on the Fox alert. However, most of this section presents facts and analysis that are applicable to all seven alerts. This analysis can be separated into three areas:

- 1) Did Iraq have the capability to use chemical agents—particularly blister agents like Mustard and Lewisite—in Kuwait near Al Jaber?
- 2) If a detector did alert to possible agent presence, could the detector have registered a false alarm?
- 3) Did attempts at confirmation supply any additional information that aids in confirmation or denial of a detection?

### ***Analysis of Iraqi Chemical Weapons Capabilities***

The Iraqi armed forces could deliver chemical weapons in a variety of ways: artillery, aircraft, and surface-to-surface missiles. Although U.S. intelligence reported that chemical mines also might be used, none were found by the United Nations (UN) Special Commission, coalition military forces, or civilian Explosive Ordnance Disposal (EOD) teams; over 300,000 conventional (non-chemical) mines were cleared from Kuwait.<sup>81</sup> In response to a question from the Presidential Advisory Committee asking if there was any evidence that Iraq “deployed any land mines that had chemical weapons”, Mr. Mitrokhin representing UNSCOM said, “We’ve seen nothing, absolutely nothing.”<sup>82</sup> Iraq did produce and deploy Mustard munitions within Iraq borders, with the closest chemical munitions found 200 kilometers away at Khamisiyah. Iraq used Mustard munitions during the war with Iran (1983 - 1988). No Lewisite was found in the Iraqi inventory by the UN Special Commission after the war.<sup>83</sup>

As noted above, the Iraqi Army had 155mm artillery for Mustard delivery. After the war, UN Inspection Teams found and destroyed 12,792 Mustard filled 155mm projectiles in Iraq.<sup>84</sup> No

<sup>79</sup> Interviews with EOD Technicians from the 1<sup>st</sup> and 2<sup>nd</sup> Platoons, Lead Sheets 5277, 5278, 5296, 5331, 5390.

<sup>80</sup> *Ordnance destroyed in SWA*, NAVEODTECHEN, 1997. Note, Table A shows all USMC ordnance found to be unfit for transport back to the U.S. and destroyed in place as well as some foreign ordnance on the bottom of this list.

<sup>81</sup> *Iraqi Ordnance Clean-up Operations in Kuwait*, IIR 7 7171 0082 97, Defense Intelligence Agency, June 1997.

<sup>82</sup> Statement by Mr. Igor Mitrokhin, UN Special Commission, to the Presidential Advisory Committee on Gulf War Veterans’ Illnesses, July 29, 1997.

<sup>83</sup> *The United Nations and the Iraq-Kuwait Conflict*, United Nations, New York, 1996, Document 189, p.656-657.

<sup>84</sup> *Ibid.* p.656-657.

other Mustard ground delivery munitions were located. Most of the Marines interviewed noted the absence of Iraqi 155mm artillery near the base. All available Marine EOD records show no Iraqi 155mm ammunition was found or destroyed in this area after the war. Additionally, EOD did not find any chemical munitions in the vicinity of Al Jaber. However, the Defense Intelligence Agency (DIA) cannot definitively give the location of all Iraqi 155mm artillery pieces in Kuwait at the time of the event, so there is a possibility that there were some within shelling range of Al Jaber on the night of February 25. These systems did have non-chemical roles and conventional (non-chemical) 155mm ammunition may have been found in an ammunition supply point near Kuwait City.<sup>85</sup>

Iraqi aircraft did not fly ground attack sorties after January 25th.<sup>86</sup> This rules out the possibility of an air-delivered chemical strike on February 25<sup>th</sup>. Additionally, no SCUD Surface-to-Surface Missiles were fired during the period in question.<sup>87</sup>

DIA has made the following statement:

Our current understanding is that Iraq did not deploy CW into Kuwait during the Gulf War. The furthest south Iraqi CW has been found is at Khamisiyah, Iraq.<sup>88</sup>

There are several reasons to believe that the Iraqis never deployed CW into Kuwait. First, there is no confirmed evidence that they did so. Neither Kuwait nor the explosive ordnance disposal (EOD) companies assisting the Kuwaitis have reported finding any CW during cleanup operations. Iraqi troops stationed in Kuwait often did not have the best CW defensive equipment. This indicates they were not prepared to fight in a contaminated environment.

The Iraqis also feared U.S. retaliation if they used chemical weapons, and may have decided to use them only if the regime's survival were threatened. This would explain why Iraq deployed CW to Khamisiyah and An Nasiriyah, but not to Kuwait. Finally, Iraq's most well-trained and trusted forces, the Republican Guard – who were in Iraq, not Kuwait – were the units best equipped to deliver CW. Therefore, it is reasonable

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<sup>85</sup> ASP/Orchard Investigation HTML Link

<sup>86</sup> *Gulf War Air Power Survey (GWAPS), Volume II, Effects and Effectiveness*, U.S. Government Printing Office, 1993, p.109.

<sup>87</sup> *Iraqi Missile Operations During 'Desert Storm' - Update*. Jane's Intelligence Review, May 1991, p. 225.

<sup>88</sup> This was confirmed in a statement by Mr. Charles Duelfer, UN Special Commission, to the Presidential Advisory Committee (PAC) on Gulf War Veterans' Illnesses, July 29, 1997. Major Cross of the PAC asked "Do you see any evidence where any weapons were moved from the three lower depots, actually down into Kuwait, maybe brought back at some time?" Mr Duelfer answered, "We have seen no evidence of that and Iraqis have said that no movements took place other than what is described here." Mr. Duelfer was referring to movements of munitions to and from the depots near Baghdad and the three lower depots, of which the southernmost (and closest to Kuwait and Saudi Arabia) was Khamisiyah.

to conclude that any CW were stored behind these forces, not in front of them.<sup>89</sup>

### ***Fox Detection and Confirmation***

The Fox vehicle used by U.S. forces during Operation Desert Storm was a sophisticated chemical warfare agent detector. According to the manufacturer, it is possible that smoke from the nearby oil well fires could have resulted in a "false positive" detection for chemical warfare agents.<sup>90</sup> Only a thorough analysis of the printed tape can provide positive verification.

Unfortunately, the MM-1 tape is lost. It is possible to retrieve a spectrum from the Fox, since the last 72 spectra are saved in the MM-1's memory. In 1994, in response to questions raised by Congress, the Army dispatched a team to read the memory of all of the Desert Storm-era Fox vehicles. GySgt Grass's Fox Vehicle (#5604) was located and inspected in Okinawa. A memorandum states:

No spectra or extra substances were found in USMC S/N 5604 which was the vehicle which reported Lewisite and benzyl bromide detections during ODS.<sup>91</sup>

The absence of spectra could have been the result of routine maintenance done by an MM-1 operator. Two frequently performed maintenance procedures erase all data on previously performed spectra.

### ***Other Attempts At Confirmation***

Task Force Ripper's M256 testing for all seven of the incidents resulted in no positive detections of chemical agents being reported to the Task Force Ripper NBC Officer. The procedures the Task Force operated under would have required that he be informed of a positive detection. Again, it should be noted that according to US Army Chemical and Biological Defense Command (CBDCOM), when it comes to detecting Mustard, the M256 is over one hundred times more sensitive than the Fox's "Air-Hi" method.<sup>92</sup>

The Fox crew's physical reaction during the alarm is noteworthy. There were no casualties and no one recalls any garlic (Mustard) or fruity/germanium (Lewisite) smells characteristic of those chemical agents.<sup>93</sup>

The quantity of Mustard required for the MM-1 to alert in the "Air-Hi" method would be substantial. This amount of Mustard should have caused (at the least) blisters on the unprotected

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<sup>89</sup> DIA Answers to Questions from OSAGWI, Undated, 1997.

<sup>90</sup> *Analysis of MM-1 Data*, Bruker DALTRONICS, 15 July 1997.

<sup>91</sup> Summary of MM-1 Spectra, U.S. Army Chemical Biological Defense Command, 15 Feb 1994.

<sup>92</sup> Interview with CBDCOM Expert, Lead sheet 748.

<sup>93</sup> Interviews with Fox #5604 Crew, lead sheets; GySgt Grass Interview, Feb 1997.



skin of the men on the Fox's roof and the others on the ground around the Fox.<sup>94</sup> There were no recorded blister agent casualties in Task Force Ripper during the war.<sup>95</sup> In 1993, a Marine thought his illness was caused by chemical warfare agents he was exposed to during the Gulf War. However, the Marine Corps investigation in 1994 that examined several incidents including Al Jaber concluded that the Marine's reported illnesses did not exhibit "...any of the classical signs of exposure to chemical warfare agents at any time, on or since 24 February 1991."<sup>96</sup>

Al Jaber was the scene of intense activity during the ground war and in the month that followed. Yet none of the units at or around Al Jaber found any evidence of chemical weapons storage or use. Additionally, Marines in the area reported no chemical warfare casualties.

## ASSESSMENT

Over a three-day period, February 24-26, 1991, U.S. Marines were alerted seven times to don higher chemical protective clothing in response to possible chemical warfare agents. In each case, the Marines responded by following the appropriate procedures to evaluate and attempt to confirm the presence of these agents, but this investigation has uncovered no evidence to confirm the possibility. No one who conducted an M256 test reported a positive result. In the one alert reported by the Fox reconnaissance vehicle commander, the indications of an alert passed so rapidly that no spectrum was obtained, without which confirmation is not possible. Further, the Fox tape that might have provided additional information for analysis (even without the spectrum) was discarded after a senior NBC officer evaluated the tape and determined that the alert was caused by smoke from the oil well fires, not by a chemical warfare agent. Nevertheless, the Fox reconnaissance vehicle commander who saw the tape is certain that the Fox alerted to a Mustard agent.

Our efforts to find evidence of Iraqi chemical weapons in and around Al Jaber air base verified only that the Iraqis did possess chemical weapons and specifically Mustard munitions, but there is no sign that any were moved into Kuwait. After the war demolition of munitions found in Kuwait failed to turn up any chemical weapons. There are no reported chemical warfare casualties due to any of the alerts, including the Fox crew members who were outside the vehicle when the Fox's spectrometer alarmed. Finally, Mustard is a persistent agent, so some detectable traces of Mustard should have remained for days to weeks following an attack. None was reported. Based upon the information that is available and despite the seven alerts around Al Jaber air base, the presence of chemical warfare agents is "Unlikely".

This assessment is tentative, based on the information available to us to date. This case will be reassessed over time in accordance with any new information and feedback from the publication of this narrative.

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<sup>94</sup> Interview with CBDCOM Expert, Lead sheet 748.

<sup>95</sup> Interviews with Task Force Ripper NBC Officer, Lead sheet 5325.

<sup>96</sup> *Investigation to Inquire into the Circumstances surrounding the Possible Exposure of Sergeant [Name Deleted] USMC to Chemical Agents During Operation Desert Storm*. Finding 36, 1<sup>st</sup> MEF, USMC, 22 Feb 1994.

***This case is still being investigated. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DOD Persian Gulf Task Force Hot Line at 800-472-6719.***

## TAB A - Acronym Listing/Glossary

### Acronyms

ARCENT.....	US Army Central Command
ASP.....	Ammunition Supply Point
CAM.....	Chemical Agent Monitor
CBDCOM.....	Chemical Biological Defense Command
COMUSARCENT.....	Commander, US Army Central Command
CW.....	Chemical Weapon
CWA.....	Chemical Warfare Agent
DIA.....	Defense Intelligence Agency
DOD.....	Department of Defense
EOD.....	Explosive Ordnance Disposal
FSSG.....	Force Service Support Group
GWAPS.....	Gulf War Air Power Survey
IAD.....	Investigation and Analysis Division
HMMWV.....	High Mobility Multipurpose Wheeled Vehicle
LAI.....	Light Amphibious Infantry
LAV.....	Light Armored Vehicle
MALS.....	Marine Air Logistics Squadron
MarDiv.....	Marine Division
MARCENT.....	US Marine Corps Central Command
MEF/ IMEF.....	Marine Expeditionary Force
MM-1.....	Fox Mass Spectrometer
MOPP.....	Mission Oriented Protective Posture
NATO.....	North Atlantic Treaty Organization
NAVEDTECH.....	US Navy Explosive Ordnance Demolition Technician
NBC.....	Nuclear, Biological, Chemical
ODS.....	Operation Desert Storm
OSAGWI.....	Office of Special Assistant for Gulf War Illnes
PSYOPS.....	Psychological Operations
TOW.....	Tube Launched Optically Guided On Wire
UN.....	United Nations
UTM.....	Universal Trans Mercador
USMC.....	United States Marine Corps
VOS.....	Vehicle Orientation System

## Glossary

### **Blister Agents**

Mustard (H) gas was used during the later parts of World War I. In its pure state, Mustard is colorless and almost odorless. The name Mustard comes from earlier methods of production that yielded an impure, Mustard or rotten onion smelling product.

Distilled Mustard (HD) was originally produced from H by a purification process of washing and vacuum distillation. HD is a colorless to amber colored liquid with a garlic-like odor, it has less odor and a slightly greater blistering power than H and is more stable in storage. It is used as a delayed action casualty agent, the duration of which depends upon the munitions used and the weather. HD is heavier than water, but small droplets will float on the water surface and present a hazard.

Heavily splashed liquid Mustard persists one to two days or more in concentrations that produce casualties of military significance under average weather conditions and a week to months under very cold conditions. HD on soil remains vesicant for about two weeks. The persistency in running water is only a few days, while the persistency in stagnant water can be several months. HD is about twice as persistent in sea water.

Mustard acts first as a cell irritant and finally as a cell poison on all tissue surfaces contacted. Early symptoms include inflammation of the eyes; inflammation of the nose, throat, trachea, bronchi and lung tissue; and redness of the skin. Blistering or ulceration is also likely to occur. Other effects may include vomiting and fever that begin around the same time as the skin starts to redden.

Eyes are very sensitive to Mustard in low concentrations: skin damage requires a much larger concentration. HD causes casualties at lower concentrations in hot, humid weather, because the body is moist with perspiration. Wet skin absorbs more Mustard than does dry skin. HD has a very low detoxification rate; repeated exposures, therefore, are cumulative in the body.

Individuals can be protected from small Mustard droplets or vapor by wearing protective masks and impermeable protective clothing. The use of impermeable clothing and masks can protect against large droplets, splashes and smears.

*References: Department of the Army, Navy and Air Force, FM 3-9, Potential Military Chemical/Biological Agents and Compounds and NBC Equipment.*

## **Detection Paper**

Detection paper relies on certain dyes being soluble in chemical warfare agents. Normally, two dyes and one pH indicator are mixed with cellulose fibers in a paper without special coloring (unbleached). When a drop of chemical warfare agent is absorbed by the paper, it dissolves one of the pigments. Mustard agent dissolves a red dye and nerve agent a yellow. In addition, VX (a form of liquid nerve agent) causes the indicator to turn to blue which, together with the yellow, will become green/green-black.

Detection paper can thus be used to distinguish between three different types of chemical warfare agents. A disadvantage with the papers is that many other substances can also dissolve the pigments. Consequently, they should not be located in places where drops of substances such as solvent, fat, oil, or fuel can fall on them. Drops of water produce no reaction.

Depending on the spot diameter and density on the detection paper, it is possible to gauge the original size of the droplets and the degree of contamination.

*Reference: Detection of Chemical Weapons: An overview of methods for the detection of chemical warfare agents; homepage:*  
<http://www.opcw.nl/chemhaz/detect.htm>.

## **M256A1 Chemical Agent Detection Kit**

The M256A1 kit is a portable, expendable item capable of detecting and identifying hazardous concentrations of chemical agent. The M256 kit is used after a chemical attack to determine if it is safe to unmask. The M256A1 kit has replaced the M256 kit. The only difference between the two kits is that the M256A1 kit will detect lower levels of nerve agent. This improvement was accomplished by using an eel enzyme for the nerve test in the M256A1 kit in place of the horse enzyme used in the M256 kit.

*Reference: Worldwide Chemical Detection Equipment Handbook, p. 430.*

## **Mission Oriented Protective Posture (MOPP)**

The wearing of MOPP gear provides soldiers protection against all known chemical agents, live biological agents, and toxins. MOPP gear consists of the following items:

Overgarment (chemical suit)

Overboots

Mask (gas mask) with hood

Gloves

When a person is wearing MOPP gear, they can not work for very long nor can they work very fast. They may also suffer mental distress as a result of feeling closed in and will also suffer from heat stress and heat exhaustion when working in warm temperatures and at high work rates. The MOPP concept arose from the need to balance individual protection with the threat, temperature, and urgency of the mission.

Commanders can raise or lower the amount of protection through five levels of MOPP. In addition, commanders can exercise a mask-only option.

**MOPP Zero:** Individuals must carry their protective mask with them at all times. Their remaining MOPP Gear must be readily available (e.g., within the work area, fighting position, living space, etc.)

**MOPP Level One:** Individuals wear their overgarment. They must carry the rest of their MOPP gear.

**MOPP Level Two:** Individuals wear their overgarment and overboots and carry the mask with hood and gloves.

**MOPP Level Three:** Individuals wear their overgarment, overboots, and mask with hood. They carry the gloves.

**MOPP Level Four:** Individuals wear all their MOPP gear.

*Source: U.S. Army Field Manual 3-4, Headquarters Department of the Army, Washington DC, 21 October 1985.*

## ***TAB B - Units Involved***

- 7<sup>th</sup> Marine Regiment (Task Force Ripper)
  - 1/7 Marine Battalion
  - 1/5 Marine Battalion
  - 3<sup>rd</sup> Tank Battalion
  - 3/11 Marine Artillery Battalion
  - 3<sup>rd</sup> Assault Amphibian Battalion (-)
  - 1<sup>st</sup> Combat Engineer Battalion (-)
- 4<sup>th</sup> Marines (TF Grizzly)
- 1<sup>st</sup> MarDiv Forward Command Post
- 245<sup>th</sup> Psychological Operations (PSYOPS) Detachment - U.S. Army

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## ***TAB D - METHODOLOGY FOR CHEMICAL INCIDENT INVESTIGATION***

The DOD requires a common framework for our investigations and assessments of chemical warfare agent incident reports, so we turned to the United Nations and the international community which had experience concerning chemical weapons. Because the modern battlefield is complex, the international community developed investigation and validation protocols<sup>97</sup> to provide objective procedures for possible chemical weapons incidents. The standard that we are using is based on these protocols that include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation, or human or animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by an expert panel.

While the DOD methodology for investigating chemical incidents (Figure 5) is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, the methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. The major efforts in this methodology are:

- Substantiate the incident.
- Document the medical reports related to the incident.
- Interview appropriate people.
- Obtain information available to external organizations.
- Assess the results.

Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

To substantiate the circumstances surrounding an incident, the investigator searches for documentation from operational, intelligence, and environmental logs. This focuses the investigation on a specific time, date, and location, clarifies the conditions under which the incident occurred, and determines whether there is "hard" as well as anecdotal evidence.

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<sup>97</sup> "Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction," April 29, 1997. This Chemical Weapons Convention was opened for signature in Paris, France, on January 13, 1993. It has been signed by 165 States and ratified by 93 States (as of June 1997). It was signed by the U.S. on Jan 13, 1993 and ratified on April 25, 1997. Part XI of the Convention, "Investigations in Cases of Alleged Use of Chemical Weapons," details some of the procedures. [<http://www.unog.ch/frames/disarm/distreat/chemical.htm>]

Additionally, the investigator looks for physical evidence that might indicate that chemical agents were present in the vicinity of the incident, including samples (or the results of analyses of samples) collected at the time of the incident.

The investigator searches the medical records to determine if personnel were injured as a result of the incident. Deaths, injuries, sicknesses, etc. near the time and location of an incident may be telling. Medical experts should provide information about alleged chemical casualties.

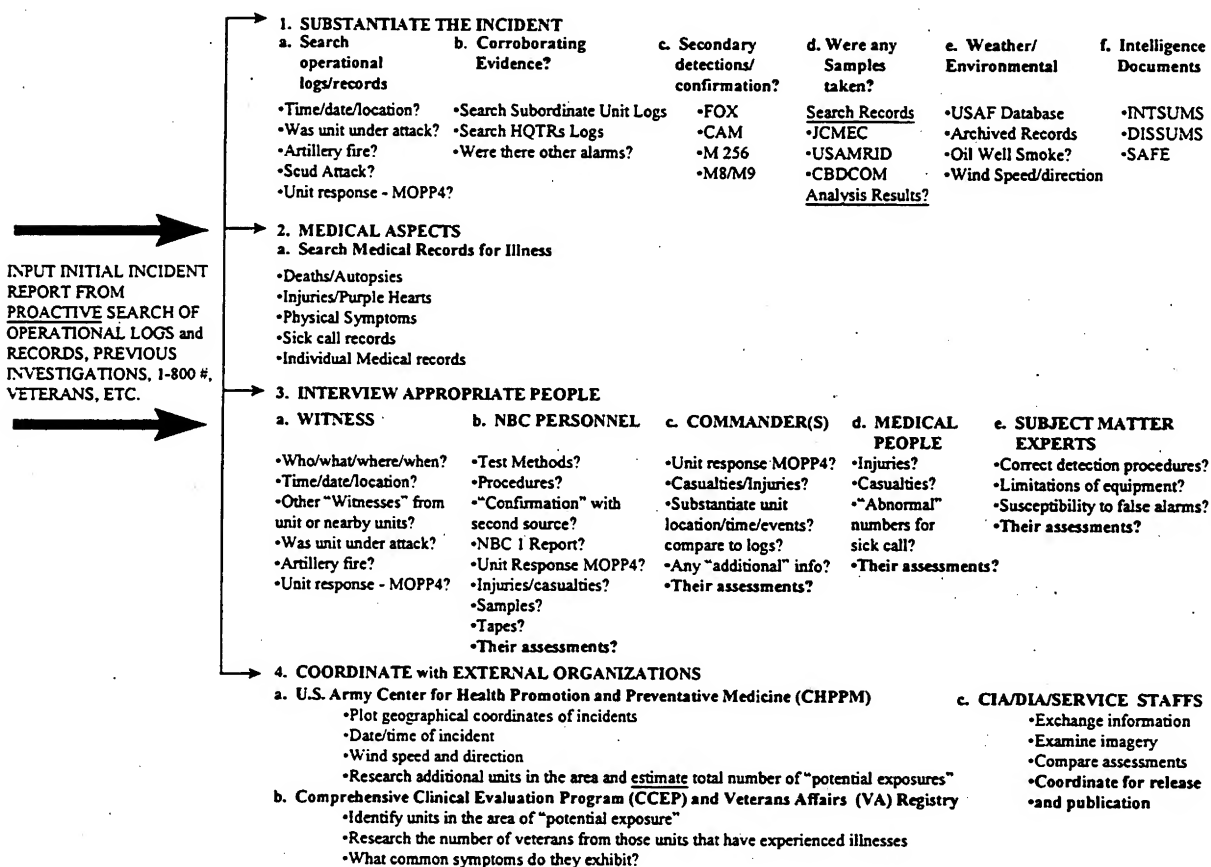


Figure 11. Chemical Incident Investigation Methodology

Interviews of incident victims (or direct observers) are conducted. First-hand witnesses provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved, and are particularly important if physical evidence is lacking. NBC officers or personnel trained in chemical and biological testing, confirmation, and reporting are interviewed to identify the unit's response, the tests that were run, the injuries sustained, and the reports submitted. Commanders are contacted to ascertain what they knew, what decisions they made

concerning the events surrounding the incident, and their assessment of the incident. Where appropriate, subject matter experts also provide opinions on the capabilities, limitations, and operation of technical equipment, and submit their evaluations of selected topics of interest.

Additionally, the investigator contacts agencies and organizations that may be able to provide additional clarifying information about the case. These would include, but not be limited to:

- Intelligence agencies that might be able to provide insight into events leading to the event, imagery of the area of the incident, and assessments of factors affecting the case.
- The DOD and Veterans' clinical registries, which may provide data about the medical condition of personnel involved in the incident.

## ***TAB E - Chronology Extracts***

Most of the units in the general vicinity of Al Jaber have recorded this alert in the unit logs. Note that the 3<sup>rd</sup> Tank Battalion did not record the event in their logs.

The 7<sup>th</sup> Marines (Task Force Ripper) noted the alert as follows:

1910 - WENT TO MOPP-4  
1920 - ALL CLEAR SOUNDED<sup>98</sup>

The 3<sup>rd</sup> Assault Amphibian Battalion recorded it as follows:

1908 Fox vehicle detected and identified Lewicite [*sic*]agent. Ripper6 believes that chemical weapons were used but not sure if Ripper was the target. These chemical munitions could have been exploded by our own artillery, thus causing secondary explosions.  
1910 Going to MOPP-4  
1920 All clear sounded.<sup>99</sup>

The 1<sup>st</sup> Combat Engineer (CE) Battalion recorded it as follows:

1910 - Fox vehicle detects Lewicite [*sic*]. TF Ripper returns to MOPP 4  
1920 -All clear<sup>100</sup>

The 11<sup>th</sup> Marines Command Chronology, which had one battalion (3/11) assigned to Task Force Ripper reports:

1911 - 3/11 REPORTS POSSIBLE GAS ATTACK; UNITS GO TO MOPP LEVEL 4.  
TF RIPPER FOX VEHICLE REPORTS DETECTING BLISTER AGENT LEWISITE AT 1918. AT 2030 DIVISION REPORTED THAT BLISTER AGENT WAS FALSE ALARM. UNITS RETURN TO MOPP LEVEL 1.<sup>101</sup>

The 11<sup>th</sup> Marines War Journal also reports:

1911: 3/11 RPTS A GAS ATK. PRIDE MAIN ALSO RPTS A GAS ATK.  
1918: RIPPER RPTS A BLISTER AGENT WHICH IS CONFIRMED BY A FOX VEHICLE. RPT SENT TO ALL BNS.<sup>102</sup>

The 11<sup>th</sup> Marines War Journal entries imply that multiple attacks/alerts are happening at the same time. Actually, 3/11 was on the Task Force Ripper communications net and would have passed along the Fox alert to its regimental headquarters. PRIDE MAIN was the call sign for the 1<sup>st</sup> MarDiv Headquarters Command Post-Main. They did not report a chemical alert at their

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<sup>98</sup> 7<sup>th</sup> Marine Logs,

<sup>99</sup> 3<sup>rd</sup> AA Bn Logs,

<sup>100</sup> Command Chronology of the 1<sup>st</sup> Combat Engineer Battalion.

<sup>101</sup> 11<sup>th</sup> Marines Chronology

<sup>102</sup> 11<sup>th</sup> Marines War Journal



location but were probably passing the Fox alert along. They received the Task Force Ripper report at 1918 (or possibly 1908 with an error in the time reporting) and recorded it without realizing that all were the same alert.

[illegible]

# Case Narrative

## An Nasiriyah Southwest Ammunition Storage Point

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on the An Nasiriyah Southwest Ammunition Storage Point and whether chemical warfare agents, chemical weapons, or biological weapons were stored there during Desert Storm and the post-war US occupation. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding the An Nasiriyah Southwest Ammunition Storage Point. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

1998069-0000-014

Last Update: July 30, 1998

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1995 to investigate all possible causes. The Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illnesses assumed responsibility for these investigations on November 12, 1996, and has continued to investigate the An Nasiriyah Southwest Ammunition Storage Point. Its interim report is contained here.

As part of the effort to inform the public about the progress of this effort, DoD is publishing (on the Internet and elsewhere) accounts related to possible causes of illnesses among Gulf War veterans, along with whatever documentary evidence or personal testimony was used in compiling the accounts. The narrative that follows is such an account.

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## METHODOLOGY

During and after the Gulf War, people reported that they had been exposed to chemical warfare agents. To investigate these incidents, and to determine if chemical weapons were used, the DoD developed a methodology for investigation and validation based on work done by the United Nations and the international community where the criteria include:

- A detailed written record of the conditions at the site
- Physical evidence from the site such as weapons fragments, soil, water, vegetation or human/animal tissue samples
- A record of the chain of custody during transportation of the evidence
- Testimony of eyewitnesses
- Multiple analyses
- Review of the evidence by experts.

While the DoD methodology (Tab D) for investigating chemical incidents is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Therefore, we cannot apply a rigid template to all incidents, and each investigation must be tailored to its unique circumstances. Accordingly, we designed our methodology to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

By following our methodology and accumulating anecdotal, documentary, and physical evidence, and by interviewing eyewitnesses and key personnel, and analyzing the results, the investigator can assess the validity of the presence of chemical warfare agents on the battlefield. Because information from various sources may be contradictory, we have developed an assessment scale (Figure 1) ranging from "Definitely" to "Definitely Not" with intermediate assessments of "Likely," "Unlikely," and "Indeterminate." This assessment is tentative, based on facts available as of the date of the report publication; each case is reassessed over time based on new information and feedback.

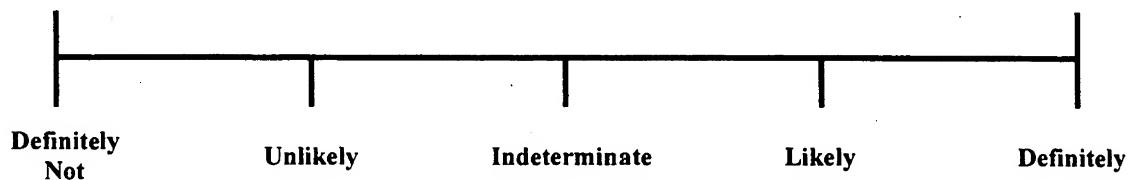


Figure 1. Assessment of Chemical Warfare Agent Presence

The standard for making the assessment is based on common sense: do the available facts lead a reasonable person to conclude that chemical warfare agents were or were not present? When insufficient information is available, the assessment is "Indeterminate" until more evidence can be found.

## SUMMARY

This investigation concerns the possible presence of chemical warfare agents, chemical weapons, and biological weapons at Iraq's An Nasiriyah Southwest Ammunition Storage Point, during, and immediately after, the Gulf War. The proximity of this ammunition storage point to Tallil Air Base, and the fact that many of the same units conducted similar operations at both installations, makes this investigation a continuation of Tallil's.

This munitions storage facility is located south of the city of An Nasiriyah and the Euphrates River and consisted of two separately fenced storage areas. The western storage area, which stored primarily army munitions, contained over 100 concrete storage bunkers, bermed storage buildings, and open storage revetments. The eastern storage area, which stored primarily air force munitions, contained a smaller number of similar storage bunkers, buildings, and open revetments. During the 1980-88 Iran-Iraq War, this installation was a major Iraqi munitions depot. During the 1990-1991 time frame, the national Intelligence Community suspected that this ASP contained chemical weapon or biological weapon munitions. By the Gulf War, the Intelligence Community had judged certain types of Iraqi bunkers to be associated with chemical weapon and biological weapon storage, including what analysts dubbed "S-shaped" and "12-frame" bunkers. This facility has one S-shaped bunker and four 12-frame bunkers. All five of these bunkers were struck by air delivered ordnance and, by February 3, 1991, had been either heavily damaged or destroyed. During the post-war US occupation and demolition, no chemical weapons or biological weapons were found at this facility, nor was any chemical agent contamination detected in the storage area. Analysis of post-war information, including information from United Nations Special Commission inspections of various Iraqi chemical weapon and biological weapon storage sites, indicates that, during Desert Storm, the Iraqis had stored chemical weapons and biological weapons in a variety of bunkers, and often in open storage. Today, the Intelligence Community believes that their pre-war assessments of suspect chemical weapon and biological weapon bunkers was inaccurate, and that, during Desert Storm, the five bunkers at An Nasiriyah Southwest probably did not store chemical weapons or biological weapons.

In 1996, in accordance with United Nations Resolution 687, Iraq declared that the more than 6,000 155mm mustard-filled artillery rounds stored in an open area 5 kilometers to the west of the Khamisiyah Ammunition Storage Point had been originally stored in a bunker at the An Nasiriyah Southwest from approximately January 15, 1991, to February 15, 1991. Iraq claims to have moved these munitions to prevent them from being destroyed by coalition air strikes. To date, United Nations Special Commission inspections, interviews, and other research support this declaration. These 155mm mustard rounds are the only chemical weapons likely to have been stored at the An Nasiriyah Southwest Ammunition Storage Point during the air campaign. Bunker 8, which according to Iraq's declaration held the munitions, was not one of five bunkers suspected of chemical weapon or biological weapon storage, and was not struck. This

bunker was searched by US ground forces during the cease-fire and destroyed by demolition charges prior to the withdrawal of US troops.

In March 1991, while identifying munitions in the vicinity of this ammunition storage point, Explosive Ordnance Disposal personnel located a damaged munition with some chemical weapon characteristics. They immediately departed the area and reported the sighting to higher headquarters. A Fox nuclear, biological, and chemical reconnaissance vehicle checked the munition and surrounding area for the presence of chemical agents and found none. Photos of this damaged munition were provided to the investigation by the photographer, the senior 60<sup>th</sup> Explosive Ordnance Disposal member.

The 9<sup>th</sup> Chemical Detachment conducted biological weapons sampling and testing operations in-theater. Some of their testing was performed at fixed sites near major Coalition installations, while other sampling missions were conducted at field sites throughout the theater. Eight biological weapons sampling missions were conducted at field sites in southern Iraq, including one at the An Nasiriyah Southwest Ammunition Storage Point. Four of the veterans interviewed for this investigation were Blackhawk helicopter crew members who supported this sampling mission on March 6, 1991. The Blackhawk crewchief's sighting of artillery shells leaking unidentified materials, as well as his knowledge that the sampling team members burned their chemical protective suits at the completion of the mission, led the crewchief to believe that the crew may have been exposed to chemical agents. Interviews with three of the biological weapons sampling team members indicate that they tested for chemical agents with M256 kits and collected soil samples for laboratory analysis. The sampling team collected five samples: one from a melted liquid from an artillery shell, one from a liquid from a different artillery shell, and three soil samples from two different bunker sites within the ammunition storage point. These samples tested negative for biological weapon associated substances. The 513<sup>th</sup> Military Intelligence Brigade chemical officer, who led this sampling team, stated that the aircrew had requested that they burn their chemical protective gear prior to departure to avoid any potential contamination of the helicopter. Interviews with Explosive Ordnance Disposal experts, Chemical Weapon technicians, and engineers involved in demolition operations at this ammunition storage point failed to uncover evidence of either chemical weapon or biological weapon presence. US troops at this installation conducted demolition operations for 5 weeks (from March 2 to April 7, 1991) without wearing chemical weapon protective gear, yet none reported or sought medical attention for symptoms of blister or nerve agent exposure.

Based on these interviews, the results of United Nations Special Commission inspections of this facility, Iraq's Chemical Weapon Full, Final, and Complete Disclosure, and a review of theater operational reports and national intelligence reporting, it is "Likely" that chemical weapons were present prior to the US occupation, and "Unlikely" that chemical weapons, biological weapons, or bulk chemical agents were present in this complex during the US occupation. Based on inspections by US and the United Nations, and considering the results of the sampling conducted by US personnel, the release of chemical agents due to bombing is also "Unlikely."

## NARRATIVE<sup>1</sup>

### Background on Iraq's Chemical Weapons Program

During the Iran-Iraq War (1980-1988), Iraq developed the ability to produce, store, and use chemical weapons (CWs). These chemical weapons included mustard blister agent (H), and G-series nerve agents like Tabun (GA) and Sarin (GB). The Iraqis also had munitions filled with White Phosphorus and riot control agents. These agents were built into various offensive munitions—122mm unguided artillery rockets, 130mm and 155mm artillery shells, 250 and 500 kilogram aerial bombs, and warheads on the Al Husayn (SCUD) missile.<sup>2</sup>

In 1990-91, US intelligence assessments indicated that Iraqi aircraft would most likely use 250 and 500 kilogram bombs to deliver chemical agents. During the Iran-Iraq war, fighter-attack aircraft dropped mustard-filled and Tabun-filled 250 kilogram bombs and mustard-filled 500 kilogram bombs on Iranian targets. Other reporting indicates that Iraq may have also installed spray tanks on an unknown number of helicopters or dropped 55-gallon drums filled with unknown agents (probably mustard) from low altitudes.<sup>3</sup>

By the start of the Gulf War, the Intelligence Community (IC) had judged that the Iraqis were using certain types of bunkers for CW and biological weapon (BW) storage, including what analysts dubbed "S-shaped" and "12-frame" bunkers.<sup>4</sup> After the war, the United Nations Special Commission (UNSCOM) investigated Iraq's CW and BW storage sites. They found that Iraq had stored chemical weapons in a variety of bunkers, and often in open storage. The IC has determined, based on these reports and other post-war information, that their pre-war assessments of Iraq's CW and BW storage practices were unreliable. However, because the An Nasiriyah Southwest (SW) Ammunition Storage Point (ASP) possessed one S-shaped and four 12-frame bunkers, it was considered a suspect CW or BW storage site.<sup>5</sup>

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<sup>1</sup> An acronym listing/glossary is at Tab A.

<sup>2</sup> Message, Subject: Iraqi Air Force Capability to Deliver Chemical Weapons, December 1, 1990. Document, Iraqi Weapons of Mass Destruction Programs, US Government, 1998, p. 15.

<sup>3</sup> Message, Subject: Iraqi Air Force Capability to Deliver Chemical Weapons, December 1, 1990.

<sup>4</sup> Message, Subject: Iraqi Chemical Warfare (CW) Facilities and Storage Areas, December 28, 1990.

<sup>5</sup> Message, Subject: Iraqi Chemical Warfare (CW) Facilities and Storage Areas, December 28, 1990. "S-shaped bunkers served as the primary factor for analysts in their identification of suspect chemical weapons storage sites before the war. The IC had assessed - for logical, analytical reasons - that S-shaped bunkers were the most likely storage sites for forward-deployed Iraqi chemical weapons. In the years following the war, however, it became clear that S-shaped bunkers were not a reliable signature for the presence of chemical munitions; in many cases the Iraqis had hidden munitions outside bunkers to protect them from Coalition airstrikes." "Lessons Learned: Intelligence Support on Chemical and Biological Warfare During the Gulf War and on Veterans' Illnesses Issues", Persian Gulf Illnesses Task Force, December 1997, p. 8.





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Figure 2. Selected Iraq CW production and storage locations<sup>6</sup>

### Background on Iraq's Biological Weapons Program

Prior to the Gulf War, Iraq was assessed to have a mature biological warfare (BW) program that had researched and produced several infectious agents to include botulinum toxin, the causative agent of botulism; *Bacillus anthracis*, the causative agent of anthrax;

<sup>6</sup> The CW production facility near Samarra was also known in Iraq as Al Muthanna. According to Iraq's UN declarations, the 155mm mustard (HD) shells stored in bunker eight at the An Nasiriyah SW ASP from January to February 1991 (before being transferred to an open storage area 5 km west of the Khamisiyah ASP) were shipped from this facility.

and *Clostridium perfringens*, the causative agent of gas gangrene.<sup>7</sup> By 1991, US agencies had identified several of Iraq's BW associated facilities.<sup>8</sup> The An Nasiriyah SW ASP was included among these facilities because it possessed four 12-frame bunkers.

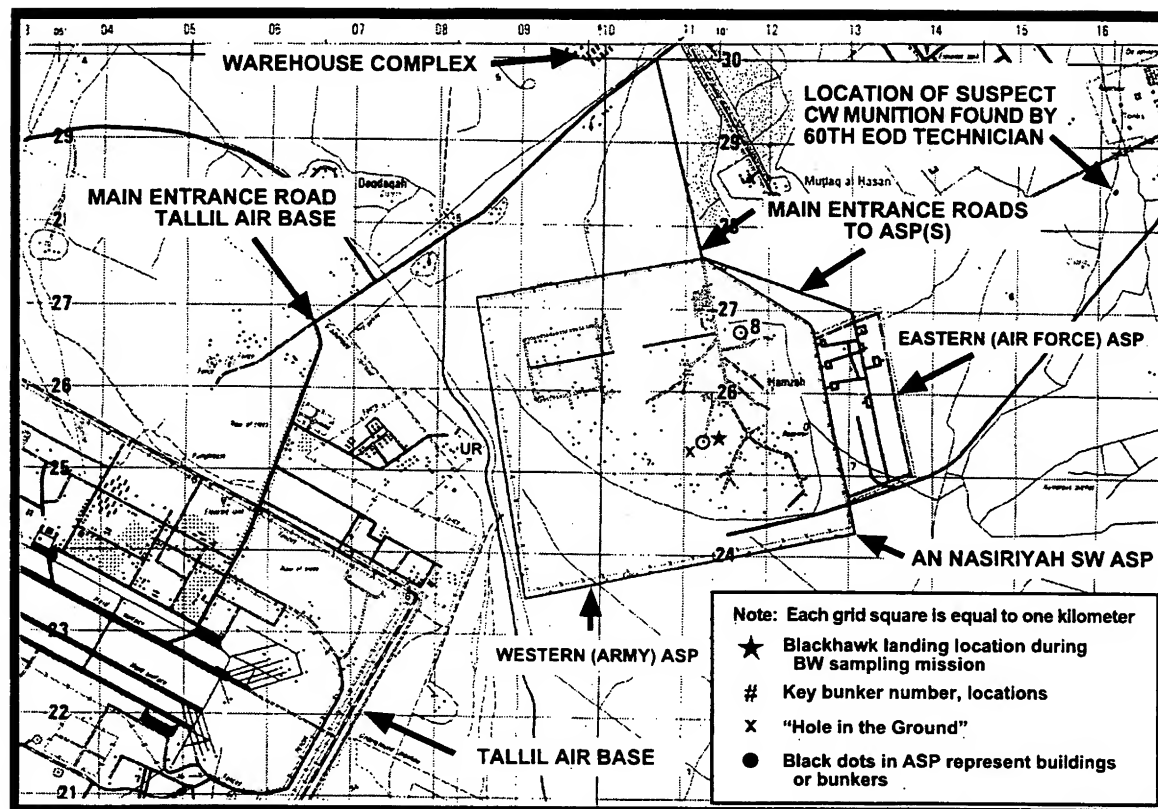


Figure 3. An Nasiriyah SW ASP

### An Nasiriyah SW ASP description

Built in the late 1970s, the An Nasiriyah SW ASP is located southwest of the city of An Nasiriyah and approximately 8 km to the northeast of Tallil Air Base (Figure 2). It is similar to the Khamisiyah ASP, which is located approximately 25 km to the southeast, in

<sup>7</sup> Message, Armed Forces Medical Intelligence, Subject: Information on Iraq's Biological Warfare Program, November 12, 1993. The most recent information on Iraq's BW program and UN declarations can be found in: "Iraqi Weapons of Mass Destruction Programs", US Government, 1998. Additional information on biological agents can be found in the glossary.

<sup>8</sup> Message, Armed Forces Medical Intelligence, Subject: Information on Iraq's Biological Warfare Program, November 12, 1993. The most recent information on Iraq's BW program and UN declarations can be found in: Document, Iraqi Weapons of Mass Destruction Programs, US Government, 1998.

area and number of storage buildings.<sup>9</sup> The An Nasiriyah SW ASP (Figure 3) includes both above-ground storage buildings and specialized munitions storage bunkers in two separately fenced areas. The western section was primarily used to store army munitions and contained four 12-frame bunkers. The eastern section was primarily used to store air force munitions and contained one S-shaped bunker. Many of An Nasiriyah's storage buildings were partially-buried, reinforced concrete bunkers. Others were above-ground structures built of brick and tin. Aerial munitions stored at this ASP supported Tallil Air Base and its fighter-attack aircraft.

### **Desert Shield and Desert Storm**

The An Nasiriyah SW ASP, along with other Iraqi facilities suspected of storing CW or BW, was carefully monitored during Desert Shield. During the Desert Storm air campaign from January 17 to February 28, 1991, Iraq's entire CW/BW research, production, and storage complex was a high priority target. Two munitions bunkers at the An Nasiriyah SW ASP were hit and destroyed by coalition air strikes on January 17, 1991. By the time of the cease-fire on February 28, 1991, approximately 22 of An Nasiriyah's munition storage bunkers had been destroyed by aerial attacks. Some of these attacks left the structures partially intact, while secondary explosions completely destroyed others.<sup>10</sup>

### **The Cease-Fire and Occupation of the An Nasiriyah SW ASP**

After the cease-fire went into effect during the morning hours of February 28, 1991, units of the 82<sup>nd</sup> Airborne Division convinced the Iraqi soldiers still occupying Tallil Air Base and the nearby An Nasiriyah SW ASP to vacate the area to the northwest or surrender without resistance. On March 1, 1991, units of the 82<sup>nd</sup> Airborne took control of the air base and nearby ASP without major incident. Units of the 82<sup>nd</sup>, including the 504<sup>th</sup> and 505<sup>th</sup> Parachute Infantry Regiments and other subordinate units, occupied both facilities and started the long process of identifying munitions and other materiel to be destroyed. While many small infantry units performed the impromptu demolition of fighting trenches, personnel bunkers, arms caches, and vehicles, most of the systematic demolition of large quantities of munitions and major facilities was performed by C Company, 307<sup>th</sup> Engineer Battalion, with the technical advice and support of the 60<sup>th</sup> Explosive Ordnance Disposal (EOD) Detachment. On March 24, 1991, the 82<sup>nd</sup> units rotated out of the area

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<sup>9</sup> The Khamisiyah ASP has also been referred to as the An Nasiriyah SE ASP. Initial references to the storage of CW at An Nasiriyah were believed to refer to the SW ASP vice the SE (Khamisiyah) ASP due to presence of an S-shaped bunker at the SW ASP site. The SE (Khamisiyah) ASP did not contain any S-shaped bunkers.

<sup>10</sup> Message, Subject: Iraqi Fallujah, Khamisiyah, and An Nasiriyah Chemical Warfare related sites, May 1996, para 4B.

and were replaced by the 2<sup>nd</sup> Armored Cavalry Regiment (ACR), the 84<sup>th</sup> Engineer Company, and the 146<sup>th</sup> EOD Detachment.<sup>11</sup>

Many of the munitions bunkers at the An Nasiriyah SW ASP had already been hit in earlier air strikes by precision guided munitions. Some of these attacks destroyed the facilities and their contents, while others initiated secondary explosions, scattering material and debris for considerable distances. Because of the extensively scattered ordnance, one of the highest priorities of local US commanders was to identify hazardous areas. Potential CW sites and unexploded ordnance were of primary concern. Chemical Corps specialists from the 82<sup>nd</sup> Airborne Division conducted CW search operations with a full range of CW detection equipment (including two Fox reconnaissance vehicles), while the 60<sup>th</sup> EOD identified and started the long process of destroying intact Iraqi ordnance.<sup>12</sup>

It is important to remember when reading the veterans interviews cited in the next sections that the title, "An Nasiriyah SW ASP," was used both by the IC and Iraq -- but not by US ground troops, who typically referred to it as Tallil, Tallil's ASP, or Tallil's bunkers. This was a result of this ASP's geographic proximity to Tallil Air Base -- at their closest point, their perimeter security fences are only 1 kilometer apart -- and the fact that aircraft munitions for use by Tallil's fighter-attack aircraft were stored in An Nasiriyah's bunkers, storage buildings, and open air revetments (see Figure 3). The Iraqi city of An Nasiriyah, after which the ASP is formally named, is located much further (approximately 10-15 kilometers) to the northeast (see Figure 2). Most of this city is located on the northern side of the Euphrates River (which US troops did not occupy when the cease-fire was in effect) and is not "directly associated" with the ASP as is Tallil Air Base.

### **The Search for Chemical Weapons<sup>13</sup>**

A March 23, 1991, message from the 82nd Airborne Division chemical officer to the 2nd Armored Cavalry Regiment chemical officer summarizes the search for chemical weapons at Tallil Air Base, An Nasiriyah SW, and Khamisiyah:

When the 82<sup>nd</sup> Abn Div initially occupied the sector, Fox vehicles and unit reconnaissance teams checked for evidence of contamination or chemical weapons. No contamination was found. Riot control agent CS was found

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<sup>11</sup> Document, 505<sup>th</sup> Parachute Infantry Regimental History, Operation Desert Shield/Storm.

<sup>12</sup> Message, Commander 82<sup>nd</sup> Airborne Division, No subject given, March 23, 1991. Interview with 82<sup>nd</sup> Airborne Division Chemical Officer, CMAT number: 1997109-024, April 21, 1997, and Interview Notes, June 17, 1996.

<sup>13</sup> To avoid confusing the reader, *The Search for Chemical Weapons*, *The Search for Biological Weapons*, and *Demolition Activities* sections of this narrative separately describe activities that in many cases occurred simultaneously. This is especially true in *The Search for Biological Weapons* section, since demolition related activities started almost as soon as the ASP was occupied on March 1<sup>st</sup>, while the helicopter inserted BW sampling mission, which is the focus of that section, did not occur until March 6<sup>th</sup>.

in the Tall al Lahm [Khamisiyah] ASP (PV 3706). White phosphorus rounds were also found. Artillery rounds with fill plugs and central bursters were found. They were marked with a yellow band. They were empty. Other rounds in the area were marked similarly. Fox reconnaissance vehicles determined they contained TNT.<sup>14</sup>

Two interviews with this individual confirmed his message and provided additional information. The division chemical officer and all subordinate chemical personnel were intimately aware of the possibility of chemical munitions in-theater. If bunkers or ASPs were suspected of containing chemical munitions, personnel were instructed to utilize the chemical agent monitor (CAM). Although he could not confirm that CAMs were employed on every bunker search or suspect munition, the division chemical officer believed that CAMs were widely available and routinely used.<sup>15</sup>

The division chemical officer also recalled that, when the 307<sup>th</sup> Engineers attempted to destroy the western portion of the ASP, an insufficient amount of explosives was used. Rather than destroying the munitions, the explosion started a fire in one bunker. This fire began to "cook-off" munitions. Based on the signature of the igniting rounds, their whistling in flight, and impact craters, he believed most to be 122mm artillery rockets. Some of the rockets exploded near the command post. Since the wind was blowing towards this area, he deployed Fox vehicles and chemical detection equipment on a nearby ridge to monitor smoke coming over the command post. No chemical detections were made at this time or when the ASP was searched. The division chemical officer also stated that none of the assigned personnel reported symptoms of chemical exposure, nor did he hear of such reports.<sup>16</sup>

Interviews with a Brigade-level chemical officer of the 82<sup>nd</sup> who supervised ASP CW search activities<sup>17</sup> and two Fox vehicle crew members who surveyed this area, confirmed that no CW was found.<sup>18</sup> The 307<sup>th</sup> Engineer Battalion intelligence officer (S-2) was also interviewed. He did not receive any reports of CW in the vicinity and never took his Mission Oriented Protective Posture (MOPP) gear out of the bag. He was in the Tallil

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<sup>14</sup> Message, Commander 82<sup>nd</sup> Airborne Division, No subject given, March 23, 1991.

<sup>15</sup> Interview with 82<sup>nd</sup> Airborne Division Chemical Officer, CMAT number: 1997109-024, April 21, 1997, and Interview Notes, June 17, 1996.

<sup>16</sup> Interview with 82<sup>nd</sup> Airborne Division Chemical Officer, CMAT number: 1997109-024, April 21, 1997, and Interview Notes, June 17, 1996.

<sup>17</sup> Interview with 82<sup>nd</sup> Airborne Brigade level Chemical Officer is documented in Transcript of Proceedings, Interviews Concerning Activities at Khamisiyah, Iraq in March 1991, CMAT number 1997143-0000062, pp. 9-29.

<sup>18</sup> Interview with Fox vehicle crew member, CMAT # 1997013-053, May 15, 1997 and Fox vehicle commander, CMAT # 1997290-0000041, October 21, 1997. Note: Only two Fox vehicles were assigned to and conducted CW survey operations in the Tallil/ASP area. Since these two individuals were assigned to two different Fox vehicles, they would have been aware of any positive samples taken by this system.

Air Base area for about a week and witnessed numerous demolition activities at the ASP.<sup>19</sup>

Because the Fox vehicle was not designed to survey bunkers, the CW search teams used hand-held testing systems—including M256 kits and CAMs—to check the bunker interiors. During an interview, a Fox vehicle crew member commented specifically on bunker searches. His vehicle was in the Tallil and An Nasiriyah ASP area for about two weeks; areas they searched included the airfield, hardened aircraft shelters, and munitions bunkers. Most of their sampling was done in the vicinity of munitions bunkers. Since the Fox was too large to enter these bunkers, they used hand-held CAMS. Most of the munitions he scanned were large tank or artillery shells. They did not have any positive readings during this survey.<sup>20</sup>

While several individuals interviewed reported that they encountered possible CW, their visual identifications were based on observed munitions color schemes like yellow or red bands, which were not reliable indicators of CW.<sup>21</sup> While performing munition identification, inventory, and demolition near the ASP, a senior member of the 60<sup>th</sup> EOD found a munition shape that had several of the physical characteristics of a chemical weapon, including thin, double-walled construction, a burster tube, and two yellow bands on the nose (see Figures 4A and 4B). He immediately departed the area and informed higher headquarters of the sighting. Two Fox reconnaissance vehicles were dispatched, surveyed the area, and found only high explosive (HE) residue.<sup>22</sup> No CW agents were detected.<sup>23</sup>

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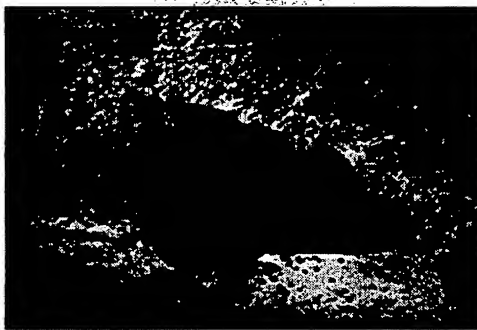
<sup>19</sup> Interview with 307<sup>th</sup> Engineer Bn S-2 intelligence officer, CMAT # 1997162-0000968, September 15, 1997.

<sup>20</sup> Interview with Fox vehicle crewmember, CMAT # 1997013-053, May 15, 1997.

<sup>21</sup> Interviews with engineers who reported that they saw CW (based on color bands) include CMAT # 1997162-0000837 and 1997162-0000255. The first reported that he destroyed six gray bombs with red and yellow strips painted on them, the second that 5 or 10 percent of the artillery shells he observed in bunkers had white or yellow markings on the nose of the projectiles. EOD interview CMAT 1997121-0000012 specifically mentioned finding gray munitions with red bands - and they were not CW. EOD interview CMAT 1997140-0000115 mentioned that CW could be recognized by filler plugs, color (two yellow bands), double walled construction, and thin skin. He also stated that it was taken for granted that CW may not be marked or marked inconsistently, making marking schemes an unreliable indicator of CW. Additional insights on this subject are contained in "Lessons Learned: Intelligence Support on Chemical and Biological Warfare During the Gulf War and on Veterans' Illnesses Issues," Persian Gulf Illnesses Task Force, December 1997, p. 3-4. IAD is currently researching an information paper on CW markings for publication later in 1998.

<sup>22</sup> Interview with senior 60<sup>th</sup> EOD technician, CMAT # 1997140-0000115, May 23, 1997.

<sup>23</sup> 60<sup>th</sup> EOD Incident Journal, Desert Storm. This journal references the discovery of a single suspected chemical shell at coordinates several kilometers east of the An Nasiriyah SW ASP on March 7<sup>th</sup>, 1991. As indicated in the journal entry, Fox vehicles detected no chemical agents in the munitions or in the area at the coordinates given. See Figure 3 for the position of the munition.



**Figure 4A. Side view of suspected CW munition<sup>24</sup>**



**Figure 5B. Back view of suspected CW munition**

While removing equipment and weapons from a Tallil warehouse near the An Nasiriyah SW ASP, one individual from the 505<sup>th</sup> Parachute Infantry Regiment related that he became very nauseous and dizzy after being exposed to a white powder in a can.<sup>25</sup> The inhaled substance caused immediate vomiting, but the nausea only lasted one to three hours and was not severe. He did not report this incident or seek medical attention, and he did not report any lasting effects from this incident.<sup>26</sup> The unidentified powder could have been a number of different compounds, including a riot control agent, but the specific circumstances related during the interview make a follow-up determination impossible. At any rate, these symptoms are not consistent with exposure to any of the chemical warfare agents assessed to be in Iraq's inventory.

<sup>24</sup> These photos were obtained from the senior 60<sup>th</sup> EOD technician, CMAT 1997140-0000115, that spotted the munition and filed the 60<sup>th</sup> EOD report.

<sup>25</sup> This veteran did not/could not remember the specific location of the warehouse. It very well could have been the warehouse complex on the access road between Tallil and the ASP, which contained large quantities of captured equipment and weapons removed from Kuwait. See 505<sup>th</sup> PIR interview CMAT # 1997175-0000203.

<sup>26</sup> 505<sup>th</sup> PIR interview CMAT # 1997175-0000203, July 14, 1997.

## The Search for Biological Weapons<sup>27</sup>

During the 1991 Desert Storm time period, the US ability to detect biological weapons in the field was extremely limited and consisted of only experimental sampling systems and laboratory testing. This was in stark contrast to the multiple, standard issue CW detection systems (e.g., CAMs and M256 kits) that were deployed by the thousands down to the lowest level of most field units. The BW field testing capability for the entire theater (vice laboratory testing, which by definition is done in a laboratory) was performed by the 9<sup>th</sup> Chemical Detachment of the 9<sup>th</sup> Infantry Division, Ft. Lewis, Washington. An overview of the 9<sup>th</sup>'s equipment, manning, and mission follows:

The 9<sup>th</sup> Chemical Detachment provided point biological and stand-off chemical detection capabilities using the XM2 biological sampler and the XM21 chemical detector. The detachment was attached to the Foreign Material Intelligence Battalion (FMIB) for operations, rations, administrative, training, UCMJ, personnel, and logistical support. The Detachment was attached to FMIB due to similar missions to collect chemical and biological samples. FMIB had already established the procedures for the evacuation of samples from the KTO to CONUS [Continental United States] laboratories for detailed analysis. The Detachment consisted of a eight man headquarters section, seven biological detection teams and five chemical/biological detection teams ... Each [biological team] consisted of a team chief and two biological detection NCO's. Three of the teams had XM2 biological detectors and the remaining four teams had the PM-10 commercial samplers. The PM-10's were deployed to the units covering Riyadh and Dhahran due to its awkward size and shape. The five chemical/biological detection teams consisted of team chief and two chemical/biological detection NCO's. Although biological detection was the primary mission, both systems were deployed simultaneously providing dual mission coverage.<sup>28</sup>

This unit deployed to Saudi Arabia in January 1991. After receiving their equipment and logistics support, on February 1, 1991, sampling teams were dispatched to several locations to test for potential threats. Teams deployed to Kuwait City, Kuwait, and collected eight biological samples in Southern Iraq. One team was transported via a UH-

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<sup>27</sup> To avoid confusing the reader, *The Search for Chemical Weapons*, *The Search for Biological Weapons*, and *Demolition Activities* sections of this narrative separately describe activities that in many cases occurred simultaneously. This is especially true in *The Search for Biological Weapons* section, since demolition activities started almost as soon as the ASP was occupied on March 1, 1991, while the helicopter inserted BW sampling mission, which is the focus of this section, did not occur until March 6, 1991.

<sup>28</sup> History report section, 9<sup>th</sup> Chemical Detachment, 9<sup>th</sup> Infantry Division, Ft. Lewis, Washington; Joint Captured Material Exploitation Center (JCMEC) Historical Report, Operation Desert Storm.



60/Blackhawk helicopter to the An Nasiriyah SW ASP to collect BW samples. No BW agents or munitions were found.<sup>29</sup>

### **An Nasiriyah Biological Sampling Mission**

A 513<sup>th</sup> Military Intelligence Brigade Task Force Kuwait Restoration SITREP reported the following on this biological sampling mission:

1. Significant activities for 7 March 1991:
  - a. Nuclear, Biological, Chemical: On 6 Mar the Brigade chemical officer, the CENTCOM Medical Intelligence officer, and a sampling team from the 9<sup>th</sup> Chemical Company acted upon a request from CENTCOM J2 to sample a suspected biological warfare storage bunker, vicinity of An Nasiriyah, IZ [Iraq]. The team flew to the bunker complex which appears to have been destroyed by "special munitions" [Precision Guided Munitions]. The team took soil samples, a solidified substance exuding from a projectile, and some liquid present in one of the bunkers. The samples have been sent to a CONUS laboratory for analysis.<sup>30</sup>

All four UH-60/Blackhawk crew members who transported the sampling mission team to the An Nasiriyah SW ASP were located and interviewed. Due to the similar geographic locations and bunker types, two of the Blackhawk's crew members believed that they might have flown to Khamisiyah.<sup>31</sup> This belief was not unexpected or unusual - the Intelligence Community also confused the An Nasiriyah SW ASP and the Khamisiyah ASP in the 1991 time frame.<sup>32</sup>

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<sup>29</sup> History report section, 9<sup>th</sup> Chemical Detachment, 9<sup>th</sup> Infantry Division, Ft. Lewis, Washington; Joint Captured Material Exploitation Center (JCMEC) Historical Report, Operation Desert Storm.

<sup>30</sup> Message, Subject: 513<sup>th</sup> Military Intelligence Bde Task Force Kuwait Restoration SITREP, March 7, 1991, para 1A.

<sup>31</sup> The door gunner mentions in his interview (CMAT 1996176-0000016) that he showed his photos of their landing site to two analysts, one from the Presidential Advisory Committee and the other a Senate staffer, and both 'confirmed' that the photos were from Khamisiyah, which also had the same type of munition storage bunkers. This March 6, 1991, sampling mission to An Nasiriyah took place only 2 days after the very large 36 bunker demolition 'blow' at the Khamisiyah ASP, approximately 25 km to the south, on March 4, 1991.

<sup>32</sup> When Iraq declared where their CW was located to UNSCOM inspectors, they referred to the site as being near "Khamisiyah (An Nasiriyah)". The inspectors believed that they were going to visit the An Nasiriyah SW ASP site (next to Tallil) and were surprised when they were taken to a site known to the US at that time as Tall al Lahm (Khamisiyah), about 25 km farther to the south. This confusion occurred because in the 1990-91 time frame, the Intelligence Community associated the storage of CW/BW with specific bunker types. Since the An Nasiriyah SW ASP contained one CW associated S-shaped type bunker and four 12-frame BW associated storage bunkers while the Khamisiyah ASP were not thought to contain either type, Iraqi UN declarations initially were believed to be deceptive. UNSCOM inspectors later confirmed during Khamisiyah ASP inspection visits the presence of 155mm mustard-filled artillery shells (which Iraq said were originally stored at the An Nasiriyah SW ASP) and 122mm artillery rockets with Sarin-filled warheads. For additional background on this subject, see Message, Subject: Chemical

The Blackhawk aircrew members ferried the sampling team to the site. According to the pilot, the mission departed Kuwait International Airport on March 6, 1991, and flew to Tallil and the ASP. Weather hindered navigation, with the ceiling being partially obscured, visibility at 0.25-0.5 miles, with light rain and blowing sand. The mission was on the ground at the ASP for approximately two hours.<sup>33</sup>

The Blackhawk co-pilot remembers that the decision to support this mission was made on short notice. The sampling team members did not wear any insignia or identifying patches. The sampling location was a bunker located several miles east of Tallil Air Base. The ASP coordinates were programmed into Blackhawk's Doppler radar navigation system. However, when they flew to the programmed location, the gusty wind and poor visibility made it difficult to find the site. They then flew to Tallil, reoriented, and flew back to the correct site. The ASP bunker complex had been hit by numerous bombs, with munitions scattered all over the area. He also noticed that there were shells in the area that had an unknown residue on them. The sampling team donned MOPP 4 and departed the landing site to test and sample. While they were waiting, some of the aircrew discovered that one of the bunkers was wired for demolition, with explosives and detonation cord fixed to boxes of 155mm artillery shells. After they went back to the helicopter, a Humvee with one or two people came up – neither were in MOPP gear. They talked with the chem/bio people while they were burning their MOPP gear. When the sampling team finished, they boarded the Blackhawk and departed.<sup>34</sup>

This sampling mission was the subject of a July 23, 1995, Belleville, IL. *News-Democrat* article, *Gulf War Veteran Details his Illness*. In it, the Blackhawk's crewchief is quoted at length concerning his observations and concern that his current health problems have been caused by this mission.<sup>35</sup> The interview with the door gunner revealed similar concerns.<sup>36</sup>

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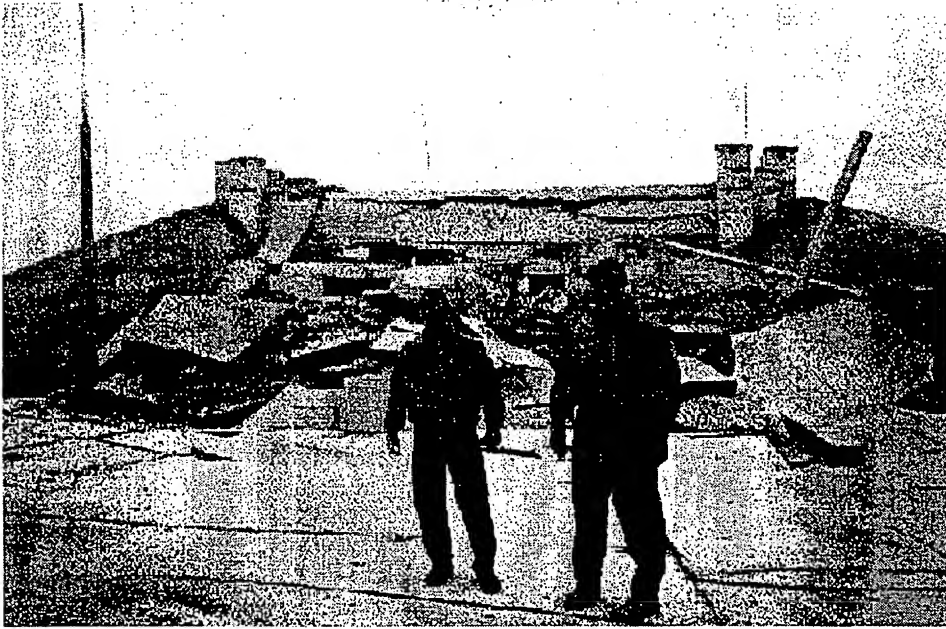
Rocket Destruction at Khamisiyah, June 1992; Message, Subject: Working Paper Mentioning Possible CW Exposure, 1992; and Message, Subject: UNSCOM 20 (CW 6) Inspection Results of Kamisiyah Ammunition Storage Facility.

<sup>33</sup> Interview with mission pilot, CMAT # 1997105-017, April 15, 1997.

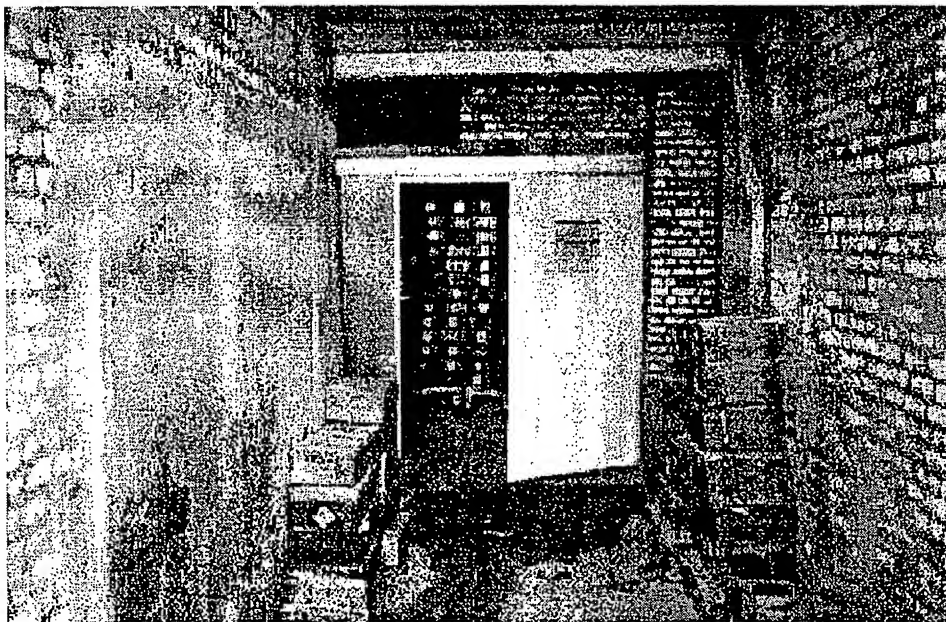
<sup>34</sup> Interview with co-pilot, CMAT # 1997107-001, April 17, 1997.

<sup>35</sup> Rod Hafemeister, "Gulf War Veteran Details his Illness," *News-Democrat*, Belleville, IL, July 23, 1995, p.1. Interview with Blackhawk crewchief, CMAT # 1995361-0000001, February 2, 1997 and April 18, 1997. Other *News-Democrat* articles on this mission include: "Chemical Weapons Found Before Blast," July 1, 1996, and "Reservists Questioned About Weapons", October 1, 1996.

<sup>36</sup> Interview with Blackhawk door gunner, CMAT #1996176-0000016, May 13, 1997.



**Figure 5A. Blackhawk crew members in front of bunker**



**Figure 5B. Demolition rigging inside ASP bunker**



**Figure 5C. BW sample team members discarding MOPP gear**



**Figure 5D. BW sample team burning MOPP gear**

The 513<sup>th</sup> MI Brigade chemical officer who was in charge of the CW/BW sampling team remembers taking another officer and two enlisted technicians. The mission was to test for CW and take samples at a suspected BW bunker, which he discovered had been obliterated ("it was a hole in the ground") by a direct hit from an aerial-delivered precision guided munition. They took several samples for laboratory testing. While in the ASP, they ran into several other EOD/engineer types rigging the bunkers for

demolition, one of which was an officer. Prior to departing, they burned their MOPP gear as a precaution to eliminate the possibility of contaminating the Blackhawk. This was done at the request of the helicopter crew. He was not briefed on the results of the laboratory tests.<sup>37</sup>

The second officer on the team, a medical intelligence officer assigned to the Armed Forces Medical Intelligence Center (AFMIC), remembered that, due to poor visibility, damage from aerial bombing, and munitions scattered throughout the area, they had a difficult time locating the right area, as well as a good spot to land. Samples were taken at random in the area by the 513<sup>th</sup> MI Brigade chemical officer – the medical intelligence officer did not personally collect any samples. As a former artillery officer, he was familiar with chemical artillery round characteristics and did not observe any CW in the area. As he walked through the area inspecting debris, destroyed munitions, and damaged bunkers, he saw melted HE, powder canisters, and artillery caps on the ground. He also was not briefed on the laboratory testing results for this or his other missions.<sup>38</sup>

One of the senior enlisted members of the 9<sup>th</sup>'s Chemical Detachment's BW sampling team indicated that the teams were sent anywhere that intelligence indicated the possibility of CW or BW. While he went through a number of buildings and bunkers in various locations during Desert Storm and the cease-fire period, he did not experience positives of either type.<sup>39</sup> A sergeant accompanied him on the March 6, 1991, Tallil/An Nasiriyah SW ASP sampling mission. They did not take their dedicated BW testing equipment (XM2 or PM-10), only M256 CW testing kits. The major who sent them on the ASP mission made the decision on what to test. After they arrived, they tested the indicated bunker. The readings registered negative and he did not observe any artillery shells with an unusual appearance – which, as a qualified technical expert, he would have noticed. He also mentioned that it was only after the mission that he learned the bunker had a biological weapons association.<sup>40</sup>

Several of those interviewed mentioned that they were greeted at the landing site by an engineer, who warned them that these remaining ASP bunkers were being wired for demolition, and that they should exercise caution. This individual was the operations officer for the Headquarters and Headquarters Company (HHC), 307<sup>th</sup> Engineer Battalion. The battalion had been conducting demolition operations in the ASP since

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<sup>37</sup> Interview with 513<sup>th</sup> MI Bde chemical officer, CMAT #1997337-0000024, December 3, 1997.

<sup>38</sup> Interview with AFMIC medical intelligence officer, CMAT #1998069-0000011, March 9, 1998.

<sup>39</sup> Interview with 9<sup>th</sup> Chemical Company BW sample team SFC, CMAT #1997329-0000018, December 1, 1997.

<sup>40</sup> Interview with 9<sup>th</sup> Chemical Company BW sample team SFC, CMAT #1997329-0000018, December 1, 1997. Note: The M256 chemical agent testing kit requires performing more than a dozen steps, some timed, over a 20-30 minute period at a specific location. The 513<sup>th</sup> MI Bde chemical officer tasked the NCOs to perform M256 CW testing while he collected BW samples without the NCOs' direct observation or knowledge of the chemical officer's specific actions or activities.

March 1, 1991, without wearing MOPP gear.<sup>41</sup> There was no advance notice that the sampling team was coming. After the team landed, the operations officer walked over to the helicopter and a person came out in MOPP 4. He was a major in the Chemical corps. The chemical officer related that they had received some reports about leaking shells in the ASP. The HHC, 307<sup>th</sup> Engineer Battalion operations officer stated that he had not seen anything of the sort, and told them the depot was being rigged to be blown. The helicopter then left.<sup>42</sup>

The 9<sup>th</sup> Chemical Detachment and its BW sampling mission fell under the direct operational command of the Joint Captured Material Exploitation Center (JCMEC), which in turn was subordinate to the 513<sup>th</sup> MI Brigade. The JCMEC operations officer and the 9<sup>th</sup> Chemical Detachment Commander developed a list of potential BW sampling locations, which was then reviewed by the 513<sup>th</sup> MI Brigade operations officer and Brigade chemical officer. Prior to conducting operations, these sampling sites were also coordinated with division intelligence. According to the JCMEC Commander, all of the collected samples tested negative.<sup>43</sup>

The JCMEC operations officer was interviewed concerning BW sampling and the mission to the An Nasiriyah SW ASP. He stated that BW sampling criteria, procedures, and tasking were determined primarily by the JCMEC operations officer (i.e., himself) from US unit locational data passed from joint operations. Based on the proximity to US forces, he divided the 9<sup>th</sup> Chemical Detachment into teams for each region. They had experimental air samplers for BW sampling positioned at Riyadh, Dharhan, and King Khalid Military City, locations selected based on weather patterns and the locations of US forces. Soil samples were also collected. According to the operations officer, these were sent to Ft. Detrick, Maryland, for laboratory testing. Samples were taken from approximately 30-60 in-theater locations.<sup>44</sup>

Biological samples collected in-theater were tested at the US Army Medical Research Institute for Infectious Diseases (USAMRIID) at Ft. Detrick, Maryland. A total of five samples were collected at the An Nasiriyah SW ASP and tested by USAMRIID; one was a melted liquid from an artillery shell, one was a liquid from a different artillery shell, and three were soil samples from two different bunker sites (within the ASP). These tests were negative for BW associated substances.<sup>45</sup>

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<sup>41</sup> Interviews with 60<sup>th</sup> EOD and 307<sup>th</sup> Engineer personnel indicate that they did not wear MOPP gear during their activities at Tallil and the ASP since it had been searched and cleared by 82<sup>nd</sup> chemical personnel.

<sup>42</sup> Interview with operations officer, HHC/307<sup>th</sup> Engineer Battalion, CMAT #1997109-0000034, April 17, 1997.

<sup>43</sup> Interview with Commander, JCMEC CMAT #1997339-0000003, December 16, 1997.

<sup>44</sup> Interview with Operations officer, JCMEC, CMAT #1997344-0000033, January 9, 1998.

<sup>45</sup> US Army Medical Institute of Infectious Diseases, Special Pathogens Section, Department of Epidemiology, Disease Assessment Division Specimen Report, March 27, 1992. The testing identified several substances to include 2, 4, 5 trinitrotoluene (TNT, an explosive filler used in conventional munitions), water (with environmental contaminants to include bacteria, and various minerals). The three soil samples tested negative for anthrax. A case narrative on BW related operations during Desert Storm is

## Oozing Munitions

While at least one of the Blackhawk crew members thought that the oozing munition(s) he observed in the ASP was unusual, it is not unheard of for artillery munitions to leak, exude, or be at least partially covered with a brownish substance. At least one 307<sup>th</sup> Engineer mentioned seeing this phenomenon when rigging bunkers at Tallil and the An Nasiriyah SW ASP. He described some of the 155mm artillery rounds stored inside these bunkers as "oozing a brownish sap."<sup>46</sup>

A review of the 60<sup>th</sup> EOD Incident Journal indicates that a major demolition occurred on March 5, 1991<sup>47</sup> -- less than 24 hours prior to the arrival of the Blackhawk and the BW sampling mission on March 6, 1991. This "blow," on March 5, 1991, was much larger than any that preceded it in this ASP, and included several munition types with increased burning action. This "blow" is also notable for being the first that involved large numbers of rockets: 1,000 132mm USSR high explosive anti-tank and 1,100 122mm USSR high explosive artillery rockets. These specific rocket types are significant because this demolition, only 4 days after the ASP was occupied, matches the 82<sup>nd</sup> Division Chemical Officer's comments concerning 122mm rockets "cooking off" and landing near his Command Post.<sup>48</sup>

In order to understand this information and to answer several questions concerning munition "cook-offs," munitions oozing a brownish substance, and fizzing munitions, the Naval EOD Technical Center, Indian Head, Maryland, provided a technical review. The Center's assessment covered several situations in which it might be "normal" for an artillery munition to leak or ooze materials when subjected to high heat or pressure environments like those found in an ASP demolition. Of note, the 60<sup>th</sup> EOD Incident Journal indicates that the March 5, 1991, demolition included over 26,000 155mm HE fragmentation projectiles.<sup>49</sup> According to the Naval EOD Technical Center assessment:

Undamaged artillery projectiles or rockets that are stored correctly should not leak or present any unusual problems. However, damaged ammunition involved in an explosion and/or subjected to intense heat could experience some leaking or exudation of the munition filler through the fuze cavity or cracks in the munition case that developed during the explosion. Undamaged munitions that are subjected to intense heat, i.e., involved in a fire, could build sufficient internal pressure to cause some of the munition filler to exude through the fuze cavity.<sup>50</sup>

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being coordinated and will be published later in 1998. It will provide additional details on how samples were collected, escorted, tested, results, etc., and background on BW agents, effects, and countermeasures.

<sup>46</sup> Interview with 307<sup>th</sup> Engineer, CMAT #1997162-0000792, November 4, 1997.

<sup>47</sup> 60<sup>th</sup> EOD Incident Journal (Desert Storm), Item 60-70-DS, April 1, 1991.

<sup>48</sup> Interview with 82<sup>nd</sup> Airborne Division Chemical Officer, CMAT number: 1997109-024, April 21, 1997, and Interview Notes, June 17, 1996.

<sup>49</sup> 60<sup>th</sup> EOD Incident Journal (Desert Storm), Item 60-70-DS, April 1, 1991.

<sup>50</sup> Naval EOD Technical Center, Indian Head, Md. letter dated January 27, 1998, para 1.a.



The Naval EOD Technical Center also indicated that a visible residue and possibly a sputtering or fizzing noise may also be present when non-explosive fillers vent:

If the munition is filled with a smoke agent, such as White Phosphorus (WP), exposure to air will cause the WP to react, resulting in the burning of WP with a sputtering (fizzing?) sound and formation of white smoke. The leaking WP will eventually form a crust at the leak point that will cut off the air supply, stopping the reaction. Color of the crust can vary from a light orange to a rusty-brown color.<sup>51</sup>

A brownish residue may also have been present due to the manner in which the munitions were packed, transported, and stored. The 60<sup>th</sup> EOD Incident Journal indicates that the March 5, 1991, demolition included over 16,000 Russian 152mm artillery projectiles.<sup>52</sup> According to the Naval EOD Technical Center assessment:

Some artillery ammunition manufactured by countries of the Former Soviet Union [Russia] and the Far East are shipped and stored with plastic fuze well plugs that are colored light blue, black, brown, or reddish-brown. Plug materials may be plastic, bakelite, or phenolic. If the munition was exposed to sufficient heat, the plastic plug could melt and resolidify, giving the impression of something oozing out of the munition. Some projectiles and cartridge cases, ranging from 57mm and larger, have a thin layer of brown preservative grease applied to the projectile body and cartridge case.... Projectile fuze wells have been known to contain a thick layer of brown grease to protect the fuze-well threads, and the heating of this grease may cause it to run and possibly give the impression of a leaking munition.<sup>53</sup>

## **Demolition Activities**

The Combat Engineers who assisted the 60<sup>th</sup> EOD in destroying facilities and munitions were primarily from C Company, 307<sup>th</sup> Engineering Battalion.<sup>54</sup> More than 30 engineers from this unit have been interviewed, including platoon leaders, the executive officer, the intelligence officer, and the 307<sup>th</sup> Engineer Battalion Commander. Destroying captured munitions is not normally part of their combat duties, but because of the large quantities at this ASP, EOD personnel gave the Engineers on-the-job training and put them to work rigging explosives. During interviews with C Company engineers, they consistently

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<sup>51</sup> Naval EOD Technical Center, Indian Head, Md. letter dated January 27, 1998, para 1.b.

<sup>52</sup> 60<sup>th</sup> EOD Incident Journal (Desert Storm), Item 60-70-DS, April 1, 1991.

<sup>53</sup> Naval EOD Technical Center, Indian Head, Md. letter dated January 27, 1998 para 1.e. and 1.f.

<sup>54</sup> B Company, 307<sup>th</sup> Engineers also participated in demo activity at Tallil and the ASP, but had a more limited role due to being reassigned in early March 1991.



reported that they rigged no CW munitions and had no first-hand knowledge of CW being discovered.<sup>55</sup>

From approximately March 3 to March 10, 1991, the Commander of the 307<sup>th</sup> Engineer Battalion was physically present at Tallil. Due to the cease-fire, the presence of two Fox vehicles conducting reconnaissance operations in the ASP area,<sup>56</sup> and the lack of a specific identified CW threat, the use of M8 chemical alarms and M256 kits by engineers and EOD technicians conducting demolition operations was limited.<sup>57</sup> The day before his arrival, the 307<sup>th</sup> Engineer Battalion Commander remembers receiving a division intelligence report of a probable chemical facility at Tallil. He remembers receiving no other specific CW warnings concerning either the air base or ASP. Since the 82<sup>nd</sup> Airborne Division Chemical Corps technicians had already cleared the area, his subordinates did not wear CW protective gear while at the ASP.<sup>58</sup> The Engineer and EOD teams destroyed army munitions including small arms ammunition, mortar rounds, anti-tank rockets, artillery rockets, artillery rounds, anti-aircraft artillery rounds, tank ammunition, and explosives. They also destroyed aircraft munitions including general purpose bombs, cluster munitions, incendiary bombs, unguided rockets, air-to-air, and air-to-ground missiles. A 307<sup>th</sup> Engineer Battalion operations summary reported that they also destroyed 18 MiG aircraft. No CW items were listed.<sup>59</sup>

While C Company, 307<sup>th</sup> Engineers and the 60<sup>th</sup> EOD performed the majority of bunker demolition work at Tallil and the ASP, several other units were also involved. USAF EOD technicians from the 1703<sup>rd</sup> EOD Detachment destroyed unexploded ordnance and identified specific air-to-air and air-to-ground ordnance for shipment to rear areas. Several of these individuals, including the 1703<sup>rd</sup> EOD Commander, were interviewed; none of them saw any chemical weapons.<sup>60</sup> Organized demolition operations by units of the 82<sup>nd</sup> Airborne Division at Tallil Air Base and the An Nasiriyah ASP began on March 2, 1991, and continued through approximately March 23, 1991.

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<sup>55</sup> Interviews with C Company, 307<sup>th</sup> Engineer Battalion, 1<sup>st</sup> platoon leader, CMAT #1997162-0000175 and lead sheet 1079, October 23, 1996; 2<sup>nd</sup> platoon leader, CMAT #1997113-0000145, April 29, 1997; 3<sup>rd</sup> platoon leader, CMAT #1997-10930, April 17, 1997; and Lead sheet 1080, interview with Battalion XO, December 18, 1996.

<sup>56</sup> Interview with Fox vehicle crew member, CMAT # 1997013-053, May 15, 1997 and Fox vehicle commander, CMAT # 1997290-0000041, October 21, 1997. Note: Only two Fox vehicles were assigned to and conducted CW survey operations in the Tallil/ASP area. Since these two individuals were assigned to two different Fox vehicles, they would have been aware of any positive samples taken by this system.

<sup>57</sup> The best illustration of this occurred when the two 60<sup>th</sup> EOD technicians discovered a possible CW munition near the ASP. They immediately left the area (vice using an M256 kit) and reported the sighting. Fox vehicles responded to their report, testing the area with negative results. See Transcript of Interview with 60<sup>th</sup> EOD technician, April 10, 1997, p 21-23; Interview with senior 60<sup>th</sup> EOD technician, CMAT # 1997140-0000115, May 23, 1997. 60<sup>th</sup> EOD Incident Journal, Desert Storm.

<sup>58</sup> Interview with 307<sup>th</sup> Engineering Battalion Commander, CMAT # 1997294-0000049, May 7, 1997.

<sup>59</sup> Message, 307<sup>th</sup> Engineer Battalion Operations Summary, March 23, 1991, p. 1-5. Note: this summary does not include aircraft destroyed by US Air Force munitions nor aircraft destroyed by other units.

<sup>60</sup> Interviews with 1703<sup>rd</sup> EOD members: CMAT #1997121-0000012, May 27, 1997; CMAT #1997118-0000043, May 6, 1997; CMAT #1997063-004, March 3, 1997; CMAT #1997141-0000081, May 29, 1997; CMAT #1997121-0000014, May 14, 1997.

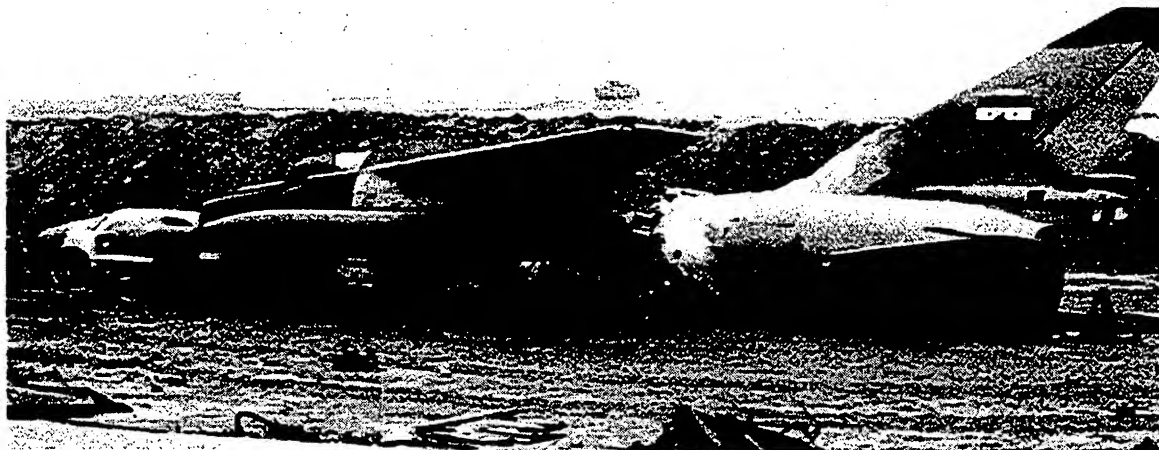


Figure 6. Destroyed fighter near ASP.

On approximately March 24, 1991, units of the 82<sup>nd</sup> Airborne Division (including C Company, 307<sup>th</sup> Engineer Battalion and the 60<sup>th</sup> EOD) rotated out of the area and were replaced by the 2<sup>nd</sup> Armored Cavalry Regiment and its supporting units, which included the 84<sup>th</sup> Engineer Company and the 146<sup>th</sup> EOD Detachment. The logs of the 146<sup>th</sup> indicate that the new units continued to destroy substantial quantities of munitions and that demolition operations at Tallil and the ASP continued into April 1991.<sup>61</sup> In an interview with the commander of the 146<sup>th</sup> EOD, he stated that he supervised the destruction of large quantities of army and air force ordnance, bunkers, aircraft, and facilities, but he did not observe any CW.<sup>62</sup>

The largest and most controversial of the demolitions at this ASP<sup>63</sup> occurred on April 2, 1991, at approximately 7:30 PM. As the former commander of the 84<sup>th</sup> Engineer Company described the situation:

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<sup>61</sup> 146<sup>th</sup> EOD Incident Journal, Desert Shield/Storm, May 15, 1991.

<sup>62</sup> Interview with 146<sup>th</sup> EOD Commander, CMAT #1997112-0000040, June 3, 1997.

<sup>63</sup> The "controversy" concerning this specific demolition was due to its size, visibility, and "lack of warning" to nearby units. The "lack of warning" aspect was primarily due to the demolition being repeatedly delayed for several hours from late afternoon to early evening due to ASP safety clearance concerns. (Iraqi nationals were grazing their sheep in the ASP -- see the 84<sup>th</sup> Engineer Company Commander comments in Interviews concerning activities at Khamisiyah, Iraq in March 1991, transcript, May 6, 1997, p. 131-134.). The repeated warnings and subsequent delays evidently caused the actual demolition time not to be taken seriously -- hence the "surprise." The dates, times, and locations of munition demolitions for both Tallil air base and the An Nasiriyah SW ASP are listed in the 60<sup>th</sup> and 146<sup>th</sup> EOD Incident Journals. Both installations were located in the "PV" grid zone, with multiple bunker locations being listed under a single UTM coordinate.

On the 2<sup>nd</sup> of April ... [a]bout 7:30, 1930 in the evening, it was dark by then. On that particular day it was fairly cold and so I think all the atmospheric conditions contributed to people hearing it and seeing it for a long, long way.... It [demolition debris] was pretty much confined to the area, but some of the stuff that we rigged were in open air pits, to use this word. [The munitions] were not stored in bunkers, [they] were just racks of bombs that the EOD guys said were aviation bombs had been moved out of Tallil just to get them out of like ready racks into some real quick, kind of hasty [revetments], scrape up some dirt and lay them out in the open. These had fuel air mixtures and kind of things, incendiaries, so when this went off ... These incendiaries looked like nuclear explosions, they had fireballs at the base, big column going up of fire, and another mushroom column at the top.<sup>64</sup>



Figure 7. Aerial munitions awaiting demolition

A 146<sup>th</sup> EOD Journal entry lists this particular event and the types of munitions blown in place (BIP) on March 30, at 6:00 AM local.<sup>65</sup> This date and time are incorrect and out of sequence with the dates immediately before and after it. The types and quantities of munitions listed correspond to the event described by the 84<sup>th</sup> Engineer Company Commander. The first 15 entries are for several thousand aircraft delivered munitions to include: Russian FAB-250s (a 500lb general purpose bomb), FAB-500s (a 1,000lb general purpose bomb), US Mk83s (a 1,000lb general purpose bomb), French Belugas (a cluster munition), and several types of Spanish incendiary munitions. The correct date

<sup>64</sup> Interviews concerning activities at Khamisiyah, Iraq in March 1991, transcript, May 6, 1997, p. 132-134.

<sup>65</sup> 146<sup>th</sup> EOD Incident Journal (Desert Shield), Activity items 146-073-DS and 146-74-DS.

for this event -- April 2, 1991, at approximately 7:30 PM -- is confirmed in another account of this demolition by a 2<sup>nd</sup> ACR unit which gives additional details:

02 Apr 91: At approximately 1945 hours [7:45 PM], the Dynamite Base Camp [call sign of the 82<sup>nd</sup> Engineer Battalion] was alerted by the sound of a tremendous explosion originating from somewhere in the north. The Battalion, as well as the Regimental [2<sup>nd</sup> ACR], FM [radio] nets began sounding like a late night radio talk show with everyone sending spot reports and everyone requesting updated information. Within a short period of time, a series of explosions lit up the sky with a fireball that was easily 800 ft high ... After the third set of explosions, information began coming over the Regimental command net that the explosions were originating from Tallil Airfield and were a result of an EOD team destroying ammunition and ordnance at the airfield.<sup>66</sup>

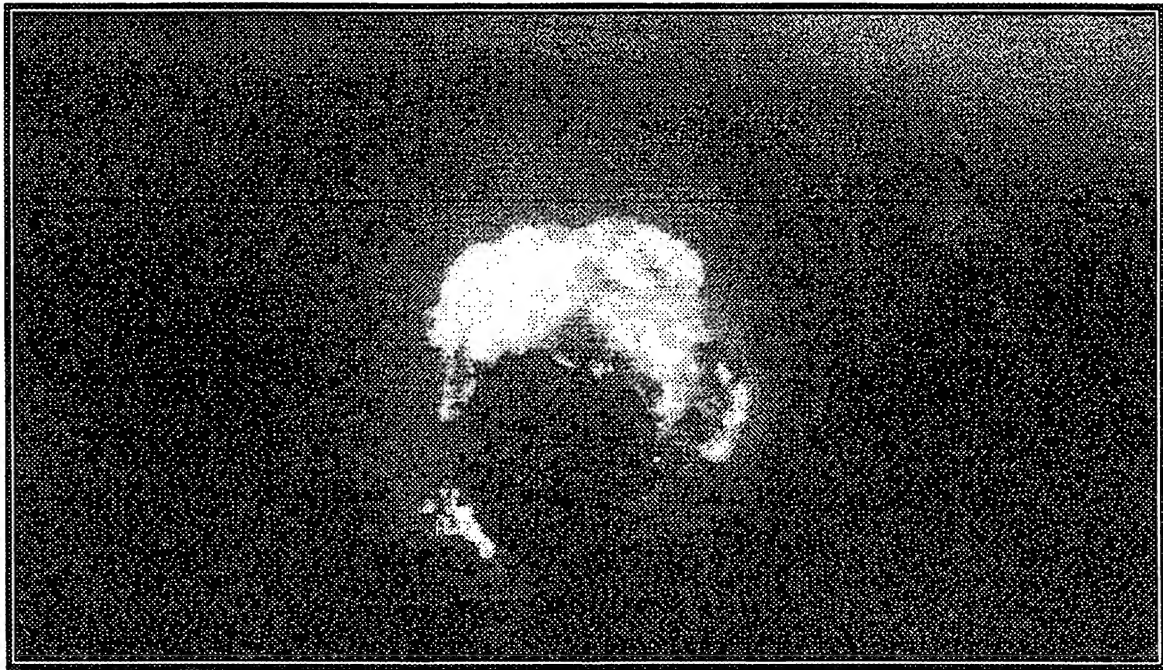


Figure 8. Photo of ASP demolition on April 2, 1991.

An interview with the 210<sup>th</sup> Field Artillery Brigade [2<sup>nd</sup> ACR's supporting artillery] executive officer also attests to the size of this demolition and the impact it had on those who witnessed it. The executive officer and his brigade commander were walking outside in the late afternoon or evening when they saw a tremendous yellowish fireball to the northeast. They both thought they saw a nuclear détonation, with a mushroom cloud following. They ordered their men to MOPP 4, which they were in for about an hour.

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<sup>66</sup> Document, Operation Desert Shield (History of 82 Engineer Battalion), May 16, 1992.

Word was later passed on their tactical radio net that US engineers had caused the explosion.<sup>67</sup>

### UNSCOM Inspection Findings

A May 1996 UNSCOM inspection of the An Nasiriyah SW ASP provided valuable insights as to activities at this facility in the January - February 1991 time period. Due to the importance of these events, several paragraphs of this trip report are quoted:

4. An Nasiriyah Storage Depot. The purpose of the inspection of An Nasiriyah was to document events surrounding the receipt, storage, and removal of approximately 6,000 Iraqi HD [mustard] munitions moved to An Nasiriyah in the mid 910100 [January 1991] time frame. The inspection team observed that 12 to 14 bunkers were in use at this site, 22 had been destroyed by coalition bombing, and over 20 had been destroyed by occupation forces.

4B. The inspection team's discussion with the Iraqi representatives centered around the delivery, storage, and movement of HD munitions from Al Muthanna [Samarra] to this site in 910100 [January 1991], specifically the following:

- Approximately 6, 000 munitions were moved from Al Muthanna [Sammara] to An Nasiriyah between 910110 [January 10, 1991] and 910115 [January 15, 1991]. The munitions were placed in Iraqi bunker number eight//geocoord: 305815.9N0461015.3E//. Also in bunker eight there were a relatively small number of 120mm HE mortar rounds and 7.9mm ball small arms ammunition.
- The munitions were removed from bunker eight and An Nasiriyah over a one week period around 910215 [February 15, 1991] and placed in an open area near Khamisiyah (Tal Al Lahm)//geocoord: 304605.3N 0462276.1E//. The inspection team examined this site and discovered no evidence of remaining munitions of any type. There is, however, a recently constructed canal adjacent to the dump site.<sup>68</sup>

In addition to Bunker 8, the UNSCOM inspection team investigated other bunkers at An Nasiriyah SW, including the remains of the S-shaped bunker and the four 12-frame bunkers. The inspectors found no evidence of CW or BW storage in any of these bunkers. They determined that the 12-frame bunkers were built and used for storage of sensitive explosives, e.g., detonation charges, detonators, TNT, etc. At the end of the

<sup>67</sup> Interview with 210<sup>th</sup> Field Artillery Executive Officer, CMAT #1997318-0000023, November 20, 1997.

<sup>68</sup> Message, Subject: Iraqi Fallujah, Khamisiyah, and An Nasiriyah Chemical Warfare related sites, May 1996, para 4(A) - 4D.

inspection, and after comparing Iraq's declarations in their CW Full, Final, and Complete Disclosure with the on-site evidence, the inspectors concluded that:

In summary, there was no indication that there are currently CW munitions stored at this site. Furthermore, there is no evidence, either physical or as a result of discussions with Iraqi representatives, that there were CW munitions indicated here in addition to those 6,000 HD [mustard 155mm artillery] munitions indicated above.<sup>69</sup>

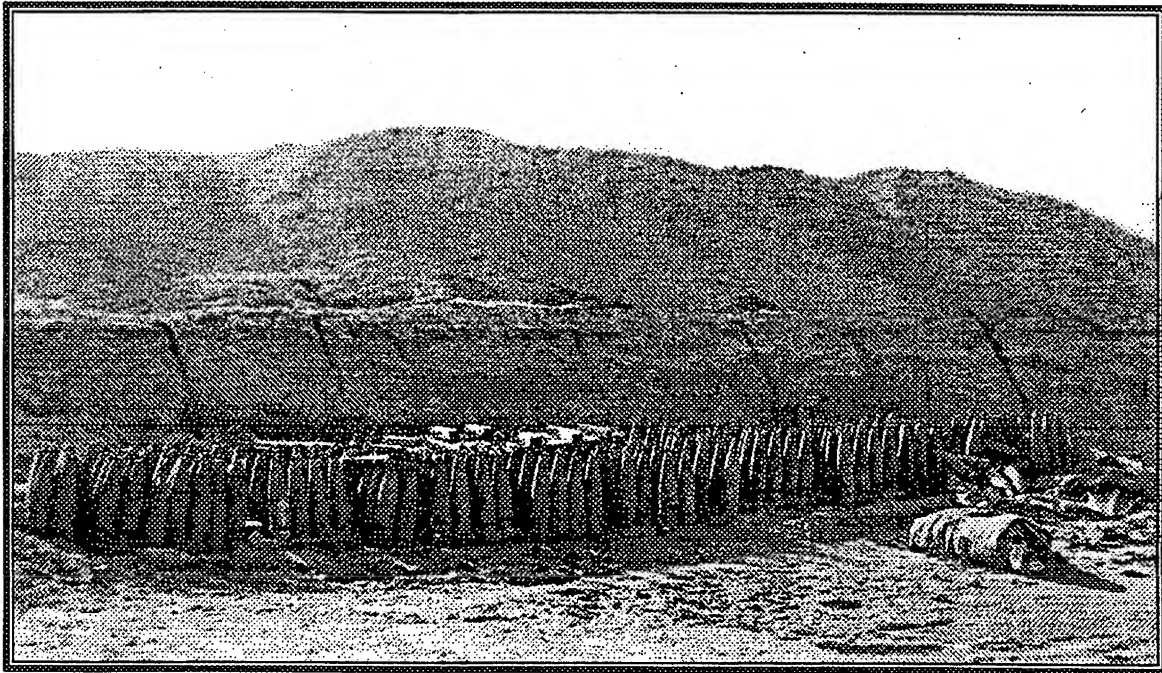


Figure 9. UNSCOM photo of 155mm mustard shells near the Khamisiyah ASP.

## ASSESSMENT

Based on Iraqi CW declarations, UNSCOM inspections, and a review of national level intelligence sources, it is likely that more than 6,000 155mm artillery shells filled with mustard agent were present at the An Nasiriyah SW ASP from about January 15 to approximately February 15, 1991. According to the May 1996, UNSCOM inspection report, these munitions were transported to this ASP just prior to the start of the coalition air campaign on January 17, 1991, and remained there while approximately 20 munition storage bunkers in this facility were attacked, seriously damaged, and/or destroyed by

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<sup>69</sup> Message, Subject: Iraqi Fallujah, Khamisiyah, and An Nasiriyah Chemical Warfare related sites, May 1996, para 4G.

aerial munitions.<sup>70</sup> According to the Iraqis, the munitions were stored in a bunker that was not attacked during the air campaign. There is no evidence, such as indications of decontamination activity, to suggest that a release of chemical agent occurred at An Nasiriyah during the air campaign. Also, when US forces occupied this facility during the cease-fire, the multiple CW testing methodologies used at this facility – to include M256 kits, CAMs, and Fox reconnaissance vehicles – would have detected gross mustard contamination.<sup>71</sup> That such contamination was not detected would confirm that these rounds were stored in a facility (or possibly an open area) that was not targeted and attacked by coalition aerial munitions. Iraq declared that these munitions were removed from this ASP around February 15, 1991, and stored in the open approximately 5 km west of the Khamisiyah ASP. The UNSCOM inspected both storage sites, these munitions, and the circumstances in which they were transported. This investigation turned up no evidence that contradicts the UNSCOM conclusion on the transport and storage of these 155mm mustard filled artillery shells.

It is unlikely that other types of CW munitions were stored at this ASP, either during the air campaign or the post war cease-fire occupation. Since this ASP and its special bunkers were bombed by coalition aircraft during the first day of the air campaign, the Iraqis almost certainly realized that this facility was high on the coalition list of targeting priorities and that any CW in storage there was at risk. All of the bunkers that the IC associated with CW or BW storage were struck, seriously damaged, or destroyed by February 3, 1991. Post-war Iraqi CW declarations and UNSCOM CW inspections indicate that Iraq initially stored 155mm mustard rounds in standard bunkers, and later, due to the air threat, out in the open near Khamisiyah.<sup>72</sup> Had Iraq stored other CW or BW munitions at An Nasiriyah, it is likely that they would have been removed along with the relocated 155mm mustard artillery shells.

Interviews with CW technicians who performed search operations with specialized testing equipment including Fox vehicles, CAMs, and M256 kits did not discover chemical weapons. EOD personnel, who are trained to identify CW by its physical characteristics, inventoried bunkers to identify munition types and quantities, and did not find CW. Due to the overwhelming quantities of munitions to be destroyed at this ASP, combat engineers assisted EOD in rigging munitions and bunkers for demolition. They did not find any CW. For 5 weeks, US troops conducted demolition operations at this ASP (from March 2 to April 7, 1991), without wearing Mission Oriented Protective

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<sup>70</sup> Message, Subject: Iraqi Fallujah, Khamisiyah, and An Nasiriyah Chemical Warfare related sites, May 1996, para 4(A) - 4D.

<sup>71</sup> Unlike Sarin (GB), which evaporates rapidly, mustard (HD) is a persistent agent that would have remained effective during the period of US activities. "The persistence of hazard from mustard vapor or liquid depends on the degree of contamination by the liquid, type of mustard, nature of the terrain and soil, type of munition used, and weather conditions. Mustard may persist much longer in wooded areas than in the open. Mustard persists two to five times longer in winter than in summer. The hazard from the vapor is many times greater under hot conditions than under cool conditions." US Army FM 8-285, Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries, Chapter 4-6 (b).

<sup>72</sup> Message, Subject: Iraqi Fallujah, Khamisiyah, and An Nasiriyah Chemical Warfare related sites, May 1996, para 4(A) - 4D.



Posture protective gear, yet none reported or sought medical attention for symptoms of blister or nerve agent exposure.

It must be noted however, that despite the dedication and technical expertise of the personnel conducting these searches, time and manpower constraints precluded a 100 percent thorough search of every bunker or every open storage revetment in this ASP. Conducting this type of search would have required that every bunker be emptied and every munition container opened. This was not done. The most expedient method entailed opening a random sample of munition containers, identifying the munition type, and multiplying this type by the observed quantity. This method was reasonably accurate but was less than 100 percent reliable.

Due to the limitations of BW sampling technology in the Desert Shield/Storm time period, an effective search for BW weapons was not conducted at this ASP.<sup>73</sup> The primary BW testing system used by the 9<sup>th</sup> Chemical Company was too large to be easily transported to this ASP, and was not taken on the March 6, 1991, BW sampling mission. While the soil samples taken did not indicate contamination by known BW agents, the area surveyed covered only a small fraction of the total area of this facility. However, there are two factors that greatly mitigate this observation. First, almost an entire month prior to the US occupation, all four of the 12-frame refrigerated storage bunkers were struck and severely damaged or destroyed by aerial munitions. Any BW stored in these four bunkers would have been exposed to the environment for almost a month, with readily observable health effects on the local Iraqi populace, livestock, and US troops.<sup>74</sup> Second, the effects of BW agents thought to be in the Iraqi inventory at that time have well known characteristics that can be readily and positively identified by medical testing procedures. No incidents of BW related illnesses or deaths were identified at this location during the war. Positive samples of one type of potential BW agent, anthrax, were identified during the Desert Shield/Storm time period, but were taken in areas associated with sheep grazing areas, where it can naturally occur.<sup>75</sup> Based on these facts, it is unlikely that BW agents or munitions were present during the US occupation.

In summary, while the munition identification and inventory process and CW/BW testing methods at this ASP were less than textbook, given the circumstances, gross CW or BW related contamination from US air strikes or ground demolition operations should and probably would have been detected. Based on the interviews, the results of UNSCOM inspections of this facility, Iraq's CW Full, Final, and Complete Disclosure, and a review of theater operational reports and national intelligence reporting, it is "Unlikely" that CW, BW, or bulk chemical agents were present in this complex while it was occupied by US

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<sup>73</sup> A case narrative on BW operations during Desert Shield/Storm is being coordinated and is expected to be published in the spring of 1998.

<sup>74</sup> The sensitivity of biological agents to high temperatures, sunlight, etc., varies according to the specific agent; a listing of biological agents and their environmental sensitivities is available in the glossary section.

<sup>75</sup> The glossary listing has more on the association of anthrax with sheep and farm animals. The soon to be published BW case narrative will cover positive livestock-associated anthrax samples in greater depth.



forces. Also, based on inspections by US and UNSCOM and on sampling by US personnel, the release of chemical agents due to bombing is also "Unlikely."

***This case is still being investigated. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DoD Persian Gulf Task Force Hot Line at***

**1-800-472-6719**

## ***TAB A - Acronym Listing/Glossary***

### **Acronyms**

ACR .....	Armored Cavalry Regiment
ASP .....	Ammunition Storage Point
BDA .....	Bomb Damage Assessment
BIP .....	Blown In Place
Bn.....	Battalion
Bde .....	Brigade
BW .....	Biological Weapon
CBW .....	Chemical or Biological Weapons
CDR .....	Commander
CIA.....	Central Intelligence Agency
CONUS .....	Continental United States
CP.....	Command Post
CS.....	Tear Gas
CW .....	Chemical Weapon
DIA .....	Defense Intelligence Agency
DoD .....	Department of Defense
EOD .....	Explosive Ordnance Disposal
FAB-500/250 .....	A type of Russian 500 or 250 kg HE bomb
FDA.....	Food and Drug Administration
FMIB.....	Foreign Material Intelligence Battalion
GA.....	Tabun nerve agent
GB.....	Sarin nerve agent
GP.....	General Purpose
H.....	Mustard chemical agent
HD.....	Mustard chemical agent
HE .....	High Explosive
HHC.....	Headquarters and Headquarters Company
Humvee .....	A type of four wheel drive utility vehicle
IAD .....	Investigations and Analysis Division
IC.....	Intelligence Community
JCMEC.....	Joint Captured Material Exploitation Center
KTO .....	Kuwait Theater of Operations
LNO .....	Liason Officer
(m).....	Micrometer
Mk-82/83/84 .....	A family of US 500lb, 1,000lb, and 2,000lb general purpose bombs
MI.....	Military Intelligence
MOPP.....	Mission Oriented Protective Posture
MOS.....	Military Occupational Specialty
SITREP .....	Situation Report
SW.....	Southwest

UCMJ.....	Uniformed Code of Military Justice
UN.....	United Nations
UNSCOM.....	United Nations Special Commission
USAF.....	US Air Force
USSR.....	Union of Soviet Socialist Republics
VX.....	A type of nerve agent
WP.....	White Phosphorous

## Glossary

**Anthrax: Signs and Symptoms:** Incubation period is 1-6 days. Fever, malaise, fatigue, cough and mild chest discomfort is followed by severe respiratory distress with dyspnea, diaphoresis, stridor, and cyanosis. Shock and death can occur within 24-36 hours of severe symptoms.<sup>76</sup>

**Overview:** *Bacillus anthracis* is a rod-shaped, gram-positive, sporulating organism, the spores constituting the usual infective form. Anthrax is a zoonotic disease with cattle, sheep and horses being the chief domesticated animal hosts, but other animals may be infected. The disease may be contracted by the handling of contaminated hair, wool, hides, flesh, blood and excreta of infected animals and from manufactured products such as bone meal, as well as by purposeful dissemination of spores. Transmission is made through scratches or abrasions of the skin, wounds, inhalation of spores, eating insufficiently cooked infected meat, or by flies. All human populations are susceptible. Recovery from a mild exposure to the disease may be followed by immunity. The spores are very stable and may remain viable for many years in soil and water. They can resist sunlight for varying periods of time.<sup>77</sup>

**Biological Toxins:** Toxins are defined as any toxic substance of natural origin produced by an animal, plant, or microbe. They are different from chemical agents such as VX, cyanide, or mustard in that they are not man-made. They are non-volatile, are usually not dermally active (mycotoxins are an exception), and tend to be more toxic per weight than many chemical agents. Their lack of volatility also distinguishes them from many of the chemical threat agents, and is very important in that they would not be either a persistent battlefield threat or be likely to produce secondary or person to person exposures. Many of the toxins, such as low molecular weight toxins and some peptides, are quite stable, where as the stability of the larger protein bacterial toxins is more variable. The bacterial toxins, such as botulinum toxins or shiga toxin, tend to be the most toxic in terms of dose required for lethality, whereas the mycotoxins tend to be among the least toxic compounds, thousands of times less toxic than the botulinum toxins. Some toxins are

<sup>76</sup> Medical Management of Biological Casualties Handbook, U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, Fredrick, Md. Second Edition, August 1996

<sup>77</sup> Medical Management of Biological Casualties Handbook, U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, Fredrick, Md. Second Edition, August 1996

more toxic by the aerosol route than when delivered orally or parenterally (ricin, saxitoxin, and T2 mycotoxins are examples), whereas botulinum toxins have lower toxicity when delivered by the aerosol route than when ingested. Botulinum is so toxic inherently, however, that this characteristic does not limit its potential as a biological warfare agent. The utility of many toxins as military weapons is potentially limited by their inherent low toxicity (too much toxin would be required), or by the fact that some which are very toxic, such as saxitoxin, can only feasibly be produced in minute quantities. The lower the lethal dose, the less agent would be required to cover a large battlefield sized area. The converse is also true, and means that for some agents such as ricin, very large quantities (tons) would be needed for an effective open-air attack. Where toxins are concerned, incapacitation as well as lethality must be considered. Several toxins cause significant illness at levels much lower than the level required for lethality, and are thus militarily significant in their ability to incapacitate soldiers. Four toxins considered to be among the most likely toxins which could be used against US forces include botulinum toxins, staphylococcal enterotoxin B (SEB), ricin, and T-2 mycotoxins.<sup>78</sup>

**Blister Agents:** Mustard (H) agent was used during the later parts of World War I. In its pure state, mustard is colorless and almost odorless. The name mustard comes from earlier methods of production that yielded an impure, mustard smelling product. Mustard is also claimed to have a smell similar to rotten onions. Distilled mustard (HD) was originally produced from H by a purification process of washing and vacuum distillation. HD is a colorless to amber colored liquid with a garlic-like odor. It has less odor and a slightly greater blistering power than H and is more stable in storage. It is used as an agent to produce casualties after a certain delay, the duration of which depends upon the munitions used, the weather and the exposure concentration. HD is heavier than water, but small droplets will float on the water surface and present a hazard. Heavily splashed liquid mustard persists one to two days or more in concentrations that produce casualties for military significance under average weather conditions and for a week to months under very cold conditions. HD on soil can cause blistering for about two weeks. The persistency in running water is only a few days, while the persistency in stagnant water can be several months. HD is about twice as persistent in sea water.<sup>79</sup>

Mustard acts first as a cell irritant and finally as a cell poison on all tissue surfaces contacted. Early symptoms include inflammation of the eyes; inflammation of the nose, throat, trachea, bronchi, and lung tissue; and redness of the skin. Blistering or ulceration are also likely to occur. Other effects may include vomiting and fever that begin around the same time as the skin starts to redden. Eyes are very sensitive to mustard in low concentrations, but skin damage requires a much larger concentration. HD causes casualties at lower concentrations in hot and humid weather, because the body is moist

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<sup>78</sup> Medical Management of Biological Casualties Handbook, U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, Md. Second Edition, August 1996.

<sup>79</sup> Headquarters, Department of the Army, Navy and Air Force, FM 3-9, Potential Military Chemical/Biological Agents and Compounds, Washington, D.C., December 1990.

with perspiration and wet skin absorbs more mustard than does dry skin. HD has a very low detoxification rate; therefore, repeated exposures are cumulative in the body. Furthermore, individuals can be sensitized to mustard. Individuals can be protected from small mustard droplets or vapor by wearing protective masks and permeable protective clothing. The use of impermeable clothing and masks can protect against large droplets, splashes, and smears.<sup>80</sup>

**Chemical Agent Monitor (CAM):** The CAM is a hand held post attack device used to monitor buildings, equipment, and personnel for contamination. The CAM is designed to detect chemical agent vapors in two modes, G and H. While in G mode the CAM can detect nerve agents. Switching to the H mode allows the CAM to detect Mustard Agents. The CAM draws in air then samples it by sensing molecular ions of specific mobility (Time of Flight) and uses timing and microprocessor techniques to reject interference. The CAM uses a graphic bar display the relative concentration of agent present.<sup>81</sup>

**Detection Paper:** Detection paper is based on certain dyes being soluble in chemical warfare agents. Normally, two dyes and one pH indicator are used, which are mixed with cellulose fibers in a paper without special coloring (unbleached). When a drop of chemical warfare agent is absorbed by the paper, it dissolves one of the pigments. Mustard agent dissolves a red dye and nerve agent a yellow. In addition, VX causes the indicator to turn to blue which, together with the yellow, will become green/green-black. Detection paper can thus be used to distinguish between three different types of chemical warfare agents. A disadvantage with the papers is that many other substances can also dissolve the pigments. Consequently, they should not be located in places where drops of solvent, fat, oil or fuel can fall on them. Drops of water give no reaction. On the basis of spot diameter and density on the detection paper, it is possible to obtain an opinion on the original size of the droplets and the degree of contamination.<sup>82</sup>

**Fox Reconnaissance Vehicle:** The Fox Nuclear Biological and Chemical (NBC) Reconnaissance Vehicle was the most sophisticated and technically complex piece of chemical detection equipment that the US used in Operations Desert Shield and Desert Storm. They were designed to provide an initial alerting mechanism to warn personnel of the possible presence of dangerous chemicals, and provide a detailed confirmation capability by means of on-board mass spectrometers. These vehicles were state-of-the-art chemical reconnaissance systems and a quantum leap in technology over existing US capabilities. Other detection equipment aboard the Fox include the M43A1 Chemical Agent Detector, the M256 Series Chemical Agent Detector Kit, the AN/VDR2 radiation detector, and the ASG1 radiation detector. The Fox was designed as a reconnaissance system, with a primary function to detect, identify, and mark persistent ground contaminated areas. Although it could detect chemical warfare agent vapors, the basic

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<sup>80</sup> Headquarters, Department of the Army, Navy and Air Force, FM 3-9, Potential Military Chemical/Biological Agents and Compounds. Washington, D.C., December 1990.

<sup>81</sup> FM 3-4 pp. 1-13 and 1-14, and CBDCOM Fact sheet for the Improved Chemical Agent Monitor (ICAM)

<sup>82</sup> Detection of Chemical Weapons: An overview of methods for the detection of chemical warfare agents.

Fox with its MM-1 mass spectrometer was not optimized for this purpose. During Operation Desert Storm, the Fox was used as a reconnaissance vehicle, as a mobile vapor detector, and as a spot detector to confirm detections from other equipment. The Fox with its MM-1 performed a quick survey check for the presence of chemicals chosen as the most likely to be present. If an alert occurred during this quick survey, a more time-consuming spectrum was necessary for confirmation. During Operation Desert Storm, interfering chemicals such as oil well fire smoke posed difficulties for the Fox's detection capabilities.<sup>83</sup>

**M256A1 Chemical Agent Detection Kit:** The M256A1 kit is a portable, expendable item capable of detecting and identifying hazardous concentrations of chemical agent. The M256 kit is used after a chemical attack to determine if it is safe to unmask. The M256A1 kit has replaced the M256 kit. The only difference between the two kits is that the M256A1 kit will detect lower levels of nerve agent. This improvement was accomplished by using an eel enzyme for the nerve test in the M256A1 kit in place of the horse enzyme used in the M256 kit.<sup>84</sup>

**M8A1 Chemical Alarm:** The M8A1 is an automatic chemical agent detection and warning system designed to detect the presence of nerve agent vapors or inhalable aerosols. The M8A1 will automatically signal the presence of the nerve agent in the air by providing troops with both a audible and visible warning. The M8A1 was fielded to replace the wet chemical M8 detector with a dry system—which eliminated the M229 refill kit, the logistic burden, and associated costs. The M8A1 operates in a fixed, portable, or vehicle mounted configuration.<sup>85</sup>

**Mission Oriented Protective Posture (MOPP):** The wearing of MOPP gear provides soldiers protection against all known chemical agents, live biological agents, and toxins. MOPP gear consists of the following items: overgarment (chemical suit), overboots; Gas mask with hood, and gloves. When a person is wearing MOPP gear, they can not work for very long nor can they work very fast. They may also suffer mental distress as a result of feeling closed in and will also suffer from heat stress and heat exhaustion when working in warm temperatures and at high work rates. The MOPP concept arose from the need to balance individual protection with the threat, temperature, and urgency of the mission. Commanders can raise or lower the amount of protection through five levels of MOPP. In addition, commanders can exercise a mask-only option.<sup>86</sup>

**MOPP Level Zero:** Individuals must carry their protective mask with them at all times. Their remaining MOPP Gear must be readily available (i.e., within the work area, fighting position, living space, etc.).

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<sup>83</sup> NBC Reconnaissance Squad/Platoon (Fox) Operations, US Field Manual 3-101-2, 10 August 1994.

<sup>84</sup> Worldwide Chemical Detection Equipment Handbook, p. 430.

<sup>85</sup> Worldwide Chemical Detection Equipment Handbook, p. 412

<sup>86</sup> U.S. Army Field Manual 3-4, Headquarters Department of the Army, Washington DC, October 1985.

**MOPP Level One:** Individuals wear their overgarment. They must carry the rest of their MOPP gear.

**MOPP Level Two:** Individuals wear their overgarment and overboots and carry the mask with hood and gloves.

**MOPP Level Three:** Individuals wear their overgarment, overboots, and mask with hood. They carry the gloves.

**MOPP Level Four:** Individuals wear all their MOPP gear.

**Nerve Agents:** Tabun (GA) is a brownish to colorless liquid agent that gives off a colorless vapor and causes casualties quickly. It was first developed by the Germans before the start of World War II. GA enters the body primarily through the respiratory tract, but it is also highly toxic through the skin and digestive tract. It is approximately 20 times more persistent than Sarin (GB) but not as stable in storage. GA has a high toxicity to the eyes, and a very low concentration of the vapors causes the pupil to constrict. This results in an individual having difficulty seeing in dim light. GA liquid penetrates the skin quickly; therefore decontamination of the smallest drop of the liquid agent is essential. The normal sequence of symptoms for vapor exposure is: running nose, tightness of chest, dimness of vision and pin-pointing of the eye pupils, difficulty breathing, drooling and excessive sweating, nausea, vomiting, cramps, involuntary defecation and urination, twitching, jerking and staggering, headache, drowsiness, coma and confusion. These symptoms are followed by cessation of breathing and death. These symptoms appear much more slowly from skin dosage than from respiratory dosage. Respiratory lethal dosages kill in 1 to 10 minutes; liquid in the eye kills nearly as fast; death may occur through skin absorption in one to two minutes; or death may also be delayed for one or two hours. A protective mask and protective clothing provide protection from all nerve agents. Protective clothing gives off G agents for about 30 minutes after contact with vapor. All liquid agent should immediately be removed from protective clothing. The persistency of GA depends upon the munitions used and the weather. Heavily splashed liquid persists one to two days under average weather conditions. It can persist about one day at 20°C and about six days at 5°C.<sup>87</sup>

Sarin gas (GB) was developed by the Germans after they developed GA. The symptoms exhibited by and protection methods used for GB are identical to GA. Death usually occurs within 15 minutes after a fatal dosage is absorbed. Soman (GD) is a colorless liquid that gives off a colorless vapor. Skin and eye toxicity is three times that of GA. Lethal respiratory and eye dosages usually kill in 1 to 10 minutes, while dosages absorbed through the skin can take up to one to two hours. The symptoms exhibited by and protection methods used for GD are identical to GA and GB. V series nerve agents are generally colorless and odorless liquids which do not evaporate rapidly. The standard

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<sup>87</sup> Headquarters, Department of the Army, Navy and Air Force, FM 3-9, Potential Military Chemical/Biological Agents and Compounds, Washington, D.C., December 1990.

V agent is VX while others include VE, VG, and VS. VX (the US standard V agent) is very persistent, odorless, amber colored liquid similar in appearance to motor oil. VX is much more persistent than G agents and causes death by the same mechanisms as G nerve agents. Since VX has a low volatility, liquid droplets on the skin do not evaporate quickly which increases its absorption. VX absorption through the skin is estimated to be more than 1000 times as toxic as GB and by inhalation is estimated to be 10 times as toxic as GB. Death usually occurs within 15 minutes after the absorption of a fatal dosage. The persistency of VX depends on the munitions and weather conditions. Heavily splashed liquid can persist for long periods under normal weather conditions. In very cold weather, VX can persist for months.<sup>88</sup>

**Sarin:** see Nerve Agents.

**UN Security Council Resolution 687:** This resolution was adopted by the UN Security Council at its 2981st meeting, on April 3, 1991. The pertinent section of this resolution, as it relates to the An Nasiriyah SW ASP narrative, follows:

6. Notes that as soon as the Secretary-General notifies the Security Council of the completion of the deployment of the United Nations observer unit, the conditions will be established for the Member States cooperating with Kuwait in accordance with resolution 678 (1990) to bring their military presence in Iraq to an end consistent with resolution 686 (1991);

Invites Iraq to reaffirm unconditionally its obligations under the Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and to ratify the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, of 10 April 1972;

Decides that Iraq shall unconditionally accept the destruction, removal, or rendering harmless, under international supervision, of:

(a) All chemical and biological weapons and all stocks of agents and all related subsystems and components and all research, development, support and manufacturing facilities;

(b) All ballistic missiles with a range greater than 150 kilometres and related major parts, and repair and production facilities; Decides, for the

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<sup>88</sup> Headquarters, Department of the Army, Navy and Air Force, FM 3-9, Potential Military Chemical/Biological Agents and Compounds, Washington, D.C., December 1990.



implementation of paragraph 8 above [paragraph 6 is only numbered paragraph in document], the following:

(a) Iraq shall submit to the Secretary-General, within fifteen days of the adoption of the present resolution, a declaration of the locations, amounts and types of all items specified in paragraph 8 and agree to urgent, on-site inspection as specified below;

(b) The Secretary-General, in consultation with the appropriate Governments and, where appropriate, with the Director-General of the World Health Organization, within forty-five days of the passage of the present resolution, shall develop, and submit to the Council for approval, a plan calling for the completion of the following acts within forty-five days of such approval.<sup>89</sup>

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<sup>89</sup> UN Security Council Resolution 687, dated April 1991.

## ***TAB B - Units Involved<sup>90</sup>***

1<sup>st</sup> Brigade, 82<sup>nd</sup> Airborne Division (also known as the 504<sup>th</sup> Parachute Infantry Regiment)

1-1<sup>st</sup> Aviation Battalion, 1<sup>st</sup> Infantry Division Aviation Brigade, 1<sup>st</sup> Infantry Division

2<sup>nd</sup> Armored Cavalry Regiment

3<sup>rd</sup> Brigade, 82<sup>nd</sup> Airborne Division (also known as the 505<sup>th</sup> Parachute Infantry Regiment)

Headquarters and Headquarters Company, 12<sup>th</sup> Aviation Brigade

1-17<sup>th</sup> Cavalry, 82<sup>nd</sup> Airborne Division Aviation Brigade

21<sup>st</sup> Chemical Company, 82<sup>nd</sup> Airborne Division

36<sup>th</sup> Medical Detachment (Helicopter Ambulance), 1<sup>st</sup> Medical Group, 44<sup>th</sup> Medical Brigade

60<sup>th</sup> Explosive Ordnance Disposal Detachment (US Army)

3-73<sup>rd</sup> Armored Battalion, 82<sup>nd</sup> Airborne Division

82<sup>nd</sup> Engineer Battalion, 2<sup>nd</sup> ACR

84<sup>th</sup> Engineer Company, 2<sup>nd</sup> ACR

87<sup>th</sup> Chemical Company, 2<sup>nd</sup> ACR

146<sup>th</sup> Explosive Ordnance Disposal Detachment (US Army)

7-158<sup>th</sup> Aviation Battalion, 12<sup>th</sup> Aviation Brigade

307<sup>th</sup> Engineer Battalion, 82<sup>nd</sup> Airborne Division

307<sup>th</sup> Medical Battalion, 82<sup>nd</sup> Airborne Division

313<sup>th</sup> Military Intelligence Battalion, 82<sup>nd</sup> Airborne Division

1-319<sup>th</sup> Field Artillery Battalion, 82<sup>nd</sup> Airborne Division

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<sup>90</sup> Units listed were within 5 km of the center of the ASP; entire units or only some individuals from the unit may have been in the vicinity.

407<sup>th</sup> Supply and Transportation Battalion, 82<sup>nd</sup> Airborne Division

450<sup>th</sup> Civil Affairs Company, 360<sup>th</sup> Civil Affairs Brigade

497<sup>th</sup> Transportation Company, 46<sup>th</sup> Corps Support Group, 1<sup>st</sup> Corps Support Command

504<sup>th</sup> Parachute Infantry Regiment (also known as the 1<sup>st</sup> Brigade, 82<sup>nd</sup> Airborne Division)

505<sup>th</sup> Parachute Infantry Regiment (also known as the 3<sup>rd</sup> Brigade, 82<sup>nd</sup> Airborne Division)

533<sup>rd</sup> Transportation Company, 46<sup>th</sup> Corps Support Group, 1<sup>st</sup> Corps Support Command

546<sup>th</sup> Transportation Company, 46<sup>th</sup> Corps Support Group, 1<sup>st</sup> Corps Support Command

603<sup>rd</sup> Transportation Company, 46<sup>th</sup> Corps Support Group, 1<sup>st</sup> Corps Support Command

782<sup>nd</sup> Maintenance Battalion, 82<sup>nd</sup> Airborne Division

1058<sup>th</sup> Transport Company, 7<sup>th</sup> Transportation Group, 22<sup>nd</sup> Support Command

1703<sup>rd</sup> EOD (US Air Force)

4404<sup>th</sup> EOD (US Air Force)

## ***TAB C - Bibliography***

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60<sup>th</sup> EOD Incident Journal (Desert Storm) 01 Apr 91.

146<sup>th</sup> EOD Incident Journal, Desert Shield/Storm, 15 May 91.

197<sup>th</sup> Infantry Brigade Desert Shield/Storm history.

307<sup>th</sup> Engineering Battalion Operations Summary, 230600Z Mar 91.

307<sup>th</sup> Engineer Battalion Chronology of Operation Desert Storm.

505<sup>th</sup> Parachute Infantry Regimental History, Operation Desert Shield/Storm.

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Interview with 9<sup>th</sup> Chemical Company BW senior enlisted sample team member, CMAT 1997329-0000018.

Interview with 60<sup>th</sup> EOD senior technician, May 23, 1997, CMAT number: 1997140-0000115.

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## ***TAB D - METHODOLOGY FOR CHEMICAL INCIDENT INVESTIGATION***

The DoD requires a common framework for our investigations and assessments of chemical warfare agent incident reports, so we turned to the United Nations and the international community which had experience concerning chemical weapons, e.g. the United Nations' investigation of the use of chemical weapons during the 1980-88 Iran-Iraq war. Because the modern battlefield is complex, the international community developed investigation and validation protocols<sup>91</sup> to provide objective procedures for possible chemical weapons incidents. The standard that we are using is based on these international protocols and guidelines that includes:

- A detailed written record of the conditions at the site
- Physical evidence from the site such as weapons fragments, soil, water, vegetation, or human or animal tissue samples
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses
- Multiple analyses
- Review of the evidence by an expert panel.

While the DoD methodology for investigating chemical incidents (Figure 1) is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence often was not collected at the time of an event. Therefore, we cannot apply a rigid template to all incidents, and each investigation must be tailored to its unique circumstances. Accordingly, we designed our methodology to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. The major efforts in our methodology are:

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<sup>91</sup> "Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction," April 29, 1997. This Chemical Weapons Convention was opened for signature in Paris, France, on January 13, 1993. It has been signed by 165 States and ratified or acceded by 106 States (as of February 1998). It was signed by the U.S. on Jan 13, 1993 and ratified on April 25, 1997. Part XI of the Convention, "Investigations in Cases of Alleged Use of Chemical Weapons," details some of the procedures. Other protocols and guidelines were found in Methodology and Instrumentation for Sampling and Analysis in the Verification of Chemical Disarmament, The Ministry for Foreign Affairs of Finland, Helsinki, Finland, 1985; Verification Methods, Handling, and Assessment Of Unusual Events In Relation To Allegations of the Use of Novel Chemical Warfare Agents, Consultant University of Saskatchewan in conjunction with the Verification Research Unit of External Affairs and International Trade Canada, March 1990; and Handbook for the Investigation Of Allegations of the Use of Chemical or Biological Weapons, Department of External Affairs, Department of National Defence, Health and Welfare Canada, and Agriculture Canada, November 1985. US Army FM 3-4/USMC FMFM 11-9, NBC Protection, May 1992; Army FM 8-285/NAVY NAVMED P-5041/AFJMAN 44-149/MARINE CORPS FMFM 11-11 (adopted as NATO FM 8-285), Treatment Of Chemical Agent Casualties and Conventional Military Chemical Injuries, US Army FM 19-20, Law Enforcement Investigations, Headquarters , Department of The Army, November 25, 1985, and other DoD investigational procedures contributed ideas for the development of this DoD methodology.



- Substantiate the incident
- Document the medical reports related to the incident
- Interview appropriate people
- Obtain information available to external organizations
- Assess the results.

A case usually starts with a report of a possible chemical incident, usually from a veteran. To substantiate the circumstances surrounding an incident, the investigator searches for documentation from operational, intelligence, and environmental logs. This focuses the investigation on a specific time, date, and location, clarifies the conditions under which the incident occurred, and determines whether there is "hard," as well as anecdotal evidence. Alarms

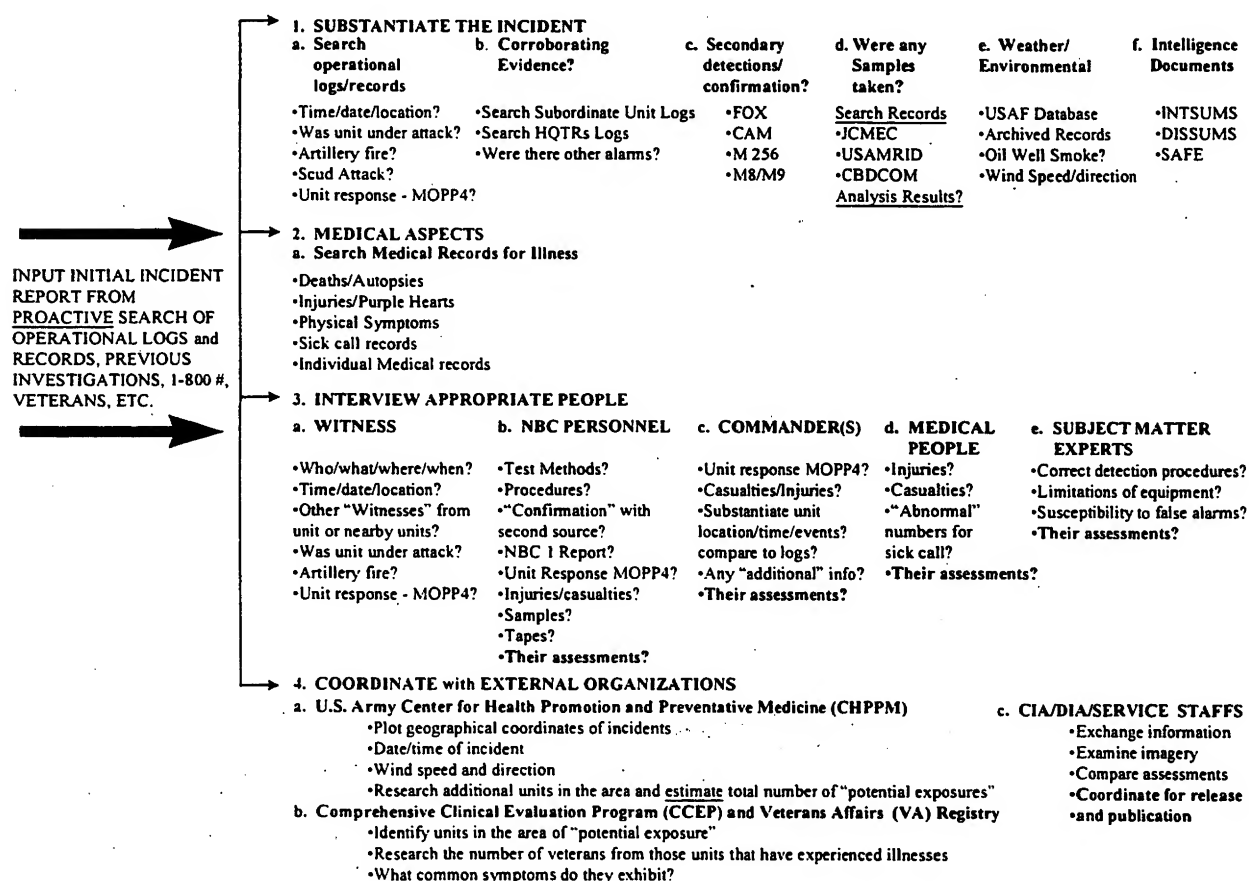


Figure 11. Chemical Incident Investigation Methodology

alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence. Additionally, the investigator looks for physical evidence that might indicate that chemical agents were

present in the vicinity of the incident, including samples (or the results of analyses of samples) collected at the time of the incident.

The investigator searches the medical records to determine if personnel were injured as a result of the incident. Deaths, injuries, sicknesses, etc. near the time and location of an incident may be telling. Medical experts should provide information about alleged chemical casualties.

Interviews of incident victims (or direct observers) are conducted. First-hand witnesses provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved, and are particularly important if physical evidence is lacking. NBC officers or personnel trained in chemical testing, confirmation, and reporting are interviewed to identify the unit's response, the tests that were run, the injuries sustained, and the reports submitted. Commanders are contacted to ascertain what they knew, what decisions they made concerning the events surrounding the incident, and their assessment of the incident. Where appropriate, subject matter experts also provide opinions on the capabilities, limitations, and operation of technical equipment, and submit their evaluations of selected topics of interest.

Additionally, the investigator contacts agencies and organizations that may be able to provide additional clarifying information about the case. These would include, but not be limited to:

- Intelligence agencies that might be able to provide insight into events leading to the event, imagery of the area of the incident, and assessments of factors affecting the case
- The DoD and Veterans' clinical registries, which may provide data about the medical condition of personnel involved in the incident.

## ***TAB E – Lessons Learned***

### **Chemical warfare agent detection**

During the Gulf War, two primary methodologies existed for detecting chemical weapons and chemical warfare agents. One was visual – munitions markings, like painted bands or symbols, or physical characteristics like thin, double-walled casings; burster tubes; welded construction; fill plugs; etc. However, these visual characteristics are not always reliable. Chemical detectors were the second available method. Unfortunately, a properly designed, manufactured, and filled chemical munition will often not emit enough chemical warfare agent vapor to be reliably detected by current M256 kits or CAMs. This presented EOD technicians with the very impractical and dangerous task of having to disassemble an unknown munition in order to positively identify if it is filled with a hazardous agent. A new detection method that can reliably detect munition contents by external sensors should be operationally deployed as soon as possible.

### **Policies and procedures for munition destruction**

Under normal non-combat conditions, EOD technicians will carefully identify each munition to be destroyed, and implement a plan that, with a high degree of safety and reliability, would render each munition inert. Due to the large quantities of munitions captured during Desert Storm, and the limited amount of time, explosives, and EOD technicians available, this was not done. Entire bunkers full of munitions were rigged for destruction without conducting a complete item-by-item inventory, and much of the demolition rigging was done by non-EOD personnel – primarily combat engineers – who were not fully trained for this mission. Due to limited demolition materials, many of the munitions in these bunkers were either ejected intact or “cooked off” over an extended period of time. These ejections and “cook-offs” placed US personnel at increased risk. Policies or directives should be developed that clearly communicate these risks to commanders, and provide explicit guidance on when and how non-EOD personnel will be used to destroy large quantities of captured munitions.

### **Mission Coordination and Communications**

Operational units responsible for demolition, including EOD and combat engineers, were not properly provided information necessary for the safe conduct of their mission. The US intelligence community had information on potential chemical and biological weapon storage sites that was not passed to the operators who occupied and destroyed them. Neither EOD nor the combat engineers who assisted them were briefed on the analytical association of S-shaped or 12-frame bunkers with chemical or biological weapons. Had this association been passed down to the operational level, these specific bunkers and a significant area around them would have certainly received additional attention from

chemical and EOD specialists. Additionally, a special biological weapons sampling mission was flown to this installation without any type of coordination with the operators who occupied it and were conducting demolition operations there. This lack of knowledge endangered everyone on this mission. Since the US Army aviation community carefully coordinates and de-conflicts operations in artillery firing zones, this same level of planning and coordination should be developed when EOD conducts demolition operations.

### **Doctrine, Tactics, Techniques, Procedures, and Training**

This sampling mission was conducted on short notice with very little coordination among the aircrew and the sampling team, and without following existing doctrine. The aircrew was not completely briefed on the nature of the mission, the potential hazards (like the demolition), and the safety precautions necessary to prevent possible CW/BW contamination. The sampling crew did not insure that all team members knew the mission objective, their specific roles, and the tasks assigned to the other members. The lack of internal communications created a situation where one of the team members did not know they were inspecting a suspected BW storage site until after the mission and an aircrew member thought the burning of MOPP gear was an unusual event, vice a prudent, conservative, safety precaution. At the same time, the team members did not understand the sample testing procedures or the notification process for positive results (and lack of notification for negative results). Their lack of knowledge regarding the "big picture" led to erroneous speculation and unnecessary concern. A thorough pre-mission brief with both the crews and the sampling teams in future chemical or biological sampling surveys would further enhance mission safety and effectiveness, and reduce misunderstandings.

# Case Narrative

## Possible Chemical Agent On Scud Missile Sample

Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This case narrative focuses on the analysis of a piece of SCUD missile that was provided to the Presidential Advisory Committee from a veteran, which was reported to cause symptoms similar to exposure to chemical warfare agents. This is an interim report, not a final report. We hope that you will read this and contact us with any information regarding this SCUD piece or similar incidents and experiences. With your help, we will be able to report more accurately on the possible evidence of chemical warfare agents on SCUD missiles. Please contact my office to report any new information by calling:

**1-800-472-6719**

Bernard Rostker  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997209-0000-094

Last Update: August 19, 1997

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DOD) established a task force in June 1995 to investigate all possible causes. The Investigation and Analysis Directorate (IAD) of the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) assumed responsibility for these investigations on November 12, 1996 and has continued to investigate evidence of Iraqi use of chemical warfare agents. This interim report concerns a piece of a SCUD missile submitted to the Presidential Advisory Committee and reported to cause symptoms similar to exposure to chemical warfare agents.

As part of the effort to inform the public about the progress of this effort, DOD is publishing (on the Internet and elsewhere) accounts related to possible causes of Gulf War illnesses, along with whatever documentary evidence or personal testimony was used in compiling the accounts. The narrative that follows is such an account.

## METHODOLOGY

During and after the Gulf War, people reported that they had been exposed to chemical warfare agents. To investigate these incidents and to determine if chemical weapons were used, the DOD developed a methodology for investigation and validation based on work done by the United Nations and the international community where the criteria include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation or human/animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by experts.

While the DOD methodology (Tab C) for investigating chemical incidents is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, our methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

By following our methodology and accumulating anecdotal, documentary, and physical evidence, and by interviewing eyewitnesses and key personnel, and analyzing the results, the investigator can assess the validity of the presence of chemical warfare agents on the battlefield. Because information from various sources may be contradictory, we have developed an assessment scale (Figure 1) ranging from "Definitely" to "Definitely Not" with intermediate assessments of "Likely," "Unlikely," and "Indeterminate." This assessment is tentative, based on facts available as of the date of the report publication; each case is reassessed over time based on new information and feedback.

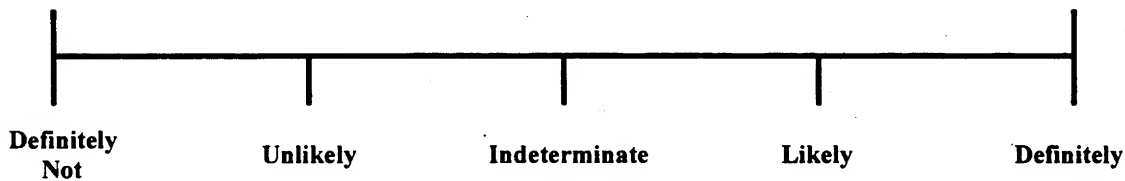


Figure 1. Assessment of Chemical Warfare Agent Presence

The standard for making the assessment is based on common sense: do the available facts lead a reasonable person to conclude that chemical warfare agents were or were not present? When insufficient information is available, the assessment is "Indeterminate" until more evidence can be found.

## SUMMARY

On September 18, 1995, a small metal sample was submitted for analysis to the Presidential Advisory Committee to determine if it contained chemical warfare agents. The sample was reported to be a piece of a SCUD missile hit by a PATRIOT missile near King Fahd Military Airport on or about January 19, 1991. Analysis of the sample by the US Army Edgewood Research and Development Center revealed no evidence of chemical warfare agents. The assessment for this case is "Unlikely" that chemical warfare agents were present.

## NARRATIVE

On September 18, 1995, a small piece of metal was provided to the Presidential Advisory Committee (PAC) on Gulf War Veterans Illnesses during a meeting in Charlotte, NC.<sup>1</sup> The person who provided this sample reported that he had been told that it was a portion of a piece from a SCUD missile hit by a PATRIOT missile near King Fahd Military Airport on January 19, 1991. He further reported the following chain of custody: the metal piece had been picked up as a souvenir by a soldier stationed there. The soldier stored the fragment in a plastic bag, forgot about it, and then rediscovered it in August 1994 in Charlotte, NC. Upon rediscovery, this soldier gave the piece to the person who provided a portion of it to the PAC.

The original piece of metal was described as being about six inches long, five inches wide, about 3/8 inches thick, and burnt on both sides. The person who provided the sample told an investigator from the Army's Foreign Materiel Program (Office of the Deputy Chief of Staff Intelligence) that:

The unprotected sample, when examined in an enclosed room with no ventilation, will cause a person's eyes to water after about 10 minutes and sometimes will cause a tingly sensation. Additionally, touching the sample will cause a burning sensation within about 10 minutes on the contacted skin. Within 20 minutes, the area is red; within 30 minutes there is a slight ring around the red part; within an hour, there is a watery blister, and within three to four hours there is a large blister. The blister will rupture on its own in six to seven hours.<sup>2</sup>

No attempt has been made to determine whether these symptoms could be duplicated, but tests were conducted to determine if chemical warfare agents were present.

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<sup>1</sup> Memorandum DAMI-ST-FM, from IOS, Foreign Materiel Program, Department of the Army, Subject: [Redacted Name] SCUD Missile, October 3, 1995; PGIIT Status Report, Subject: SCUD Missile Part, no date; Letter to Senator Rockefeller from the Office of the Secretary of Defense (Health Affairs).

<sup>2</sup> Memorandum DAMI-ST-FM, from IOS, Foreign Materiel Program, Department of the Army, Subject: [Redacted Name] SCUD Missile, October 3, 1995.

The Persian Gulf Illnesses Investigation Team (PGIIT)<sup>3</sup> and the Investigation and Analysis Directorate (IAD) have investigated reports of SCUD missile attacks in the vicinity of King Fahd Military Airport during the period of January 12-26, 1991. According to an Air Force Message, several missiles were launched during this period at Dhahran, which is near King Fahd Military Airport.<sup>4</sup> On January 19, 1991, however, the only recorded SCUD activity was three missiles fired from Iraq at Tel Aviv, Israel.<sup>5</sup> Veterans who called the Veterans Reporting Hotline have reported SCUD alerts in the vicinity of King Fahd Military Airport in that general period of time.<sup>6</sup>

The Presidential Advisory Committee gave the sample to the Department of Defense Foreign Materiel Program, which in turn arranged for the US Army Edgewood Research and Development Engineering Center (ERDEC) to test for chemical warfare agent.<sup>7</sup> ERDEC did a thorough analysis of the metal piece--using gas chromatography/mass spectrometry, nuclear magnetic resonance techniques, high performance liquid chromatography/ion chromatography, and chemical ionization. "No compounds were found in either of the leachates of the piece of metal submitted for analysis." To further test its findings, ERDEC also analyzed the spectra taken from the fragment and spectra taken from a test sample spiked with mustard agent. "All NMR and GC Mass Spec tests [were] negative."<sup>8</sup> Note that the scientists who analyzed the sample wore protective gloves and worked in a ventilated laboratory as is routine in conducting these analyses; because the scientists were not exposed to the "unprotected sample," the scientists were unable to verify the symptoms reported by person who provided the sample.

The PGIIT then arranged for the Missile and Space Intelligence Center to perform a metallurgical analysis of the sample to determine its source; the piece was found to be consistent with the metallurgical properties of SCUD missiles.<sup>9</sup> The person who provided the sample reported that he also independently submitted two other portions of the metal fragment to two commercial laboratories, but these were returned because the laboratories refused to handle the material.<sup>10</sup> The person who provided the sample was informed of all test results.<sup>11</sup>

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<sup>3</sup> The PGIIT is the predecessor organization to the Office of the Special Assistant for Gulf War Illnesses, Investigation and Analysis Directorate.

<sup>4</sup> USAF Message, Serial Number S/DQ/148-81, Defense Special Missile and Astronautics Center.

<sup>5</sup> Memorandum DAMI-ST-FM, from IOS, Foreign Materiel Program, Department of the Army, Subject: [Redacted Name] SCUD Missile, October 3, 1995 and *Special Study of the 347th's Participation in Desert Shield/Desert Storm: January - December 1991*, Vol. 1, Ninth Air Force Air Combat Command, USAF.

<sup>6</sup> SCUD alerts near King Fahd Military Airport are documented in Incident Reports 459001155 dated September 13, 1995 and 459001166 dated September 14, 1995, respectively.

<sup>7</sup> Memorandum for Director, Missile and Space Intelligence, subject Request for Analytical Support, dated December 5, 1995.

<sup>8</sup> Memorandum for Record, Subject: Analysis of Metal Scrap: Final Report, dated December 12, 1995; handwritten results of analysis signed by ERDEC analyst October 13, 1995; typed results "ANALYSES METAL PIECE - ERDEC," not signed or dated; File on Sample #OTH22395, ERDEC, November 1996. Leachates are material removed from a sample during chemical analysis.

<sup>9</sup> Memorandum, Subject: Analysis of Sample (Steel Fragment), MSIC, June 2, 1994.

<sup>10</sup> Memorandum for Record, Subject: SCUD Piece Referred to PGIT by [Redacted Name] for Analysis December 20, 1996.



## ASSESSMENT

The case assessment is "Unlikely" for the presence of chemical warfare agents based on the following:

- Based on the metallurgical analysis, the sample was probably from a SCUD.
- No evidence of chemical warfare agent contamination was found by the chemical analysis of the sample performed by ERDEC.
- However, neither the chain of custody prior to the sample's submission nor confirmation of the reported symptoms due to exposure to the sample has been established. (Because these have not been established, the case assessment is "Unlikely" rather than "Definitely Not.")

*This case is still being investigated. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DOD Persian Gulf Task Force Hot Line at 1-800-472-6719.*

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<sup>11</sup> Memorandum for Deputy Assistant Secretary of Defense (Clinical Services), Subject: Request from [Redacted Name], from PGIT, December 8, 1995; Letter from Deputy Assistant Secretary of Defense (Clinical Services) dated July 15, 1996; Letter from Director, Persian Gulf War Veterans' Illnesses Investigation Team, May 2, 1996.

## ***TAB A - ACRONYMS***

DEFSMAC.....	Defense Special Missile and Astronautics Center
ERDEC .....	Edgewood Research and Development Engineering Center
GC.....	Gas Chromatography
HPLC .....	High Performance Liquid Chromatography
IC.....	Ion Chromatography
LTC.....	Lieutenant Colonel
MS.....	Mass Spectrometry
MSIC.....	Missile and Space Intelligence Center
NC.....	North Carolina
NMR .....	Nuclear Magnetic Resonance
PAC.....	Presidential Advisory Committee
PGIIT .....	Persian Gulf Illnesses Investigation Team
US .....	United States

## ***TAB B - BIBLIOGRAPHY***

"ANALYSES METAL PIECE - ERDEC," not signed or dated.

File on Sample #OTH22395, ERDEC, November 1996.

Incident Report 459001155, September 13, 1995.

Incident Report 459001166, September 14, 1995.

Letter from Deputy Assistant Secretary of Defense (Clinical Services), July 15, 1996.

Letter from Director, Persian Gulf War Veterans' Illnesses Investigation Team, May 2, 1996.

Letter to Senator Rockefeller from the Office of the Secretary of Defense (Health Affairs).

Memorandum DAMI-ST-FM from IOS, Foreign Materiel Program, Department of the Army, Subject: [Redacted Name] SCUD Missile, October 3, 1995.

Memorandum for Deputy Assistant Secretary of Defense (Clinical Services), Subject: Request from [Redacted Name], from PGI, December 8, 1995.

Memorandum for Director, Missile and Space Intelligence, Subject: Request for Analytical Support, dated December 5, 1995.

Memorandum for Record, Subject: SCUD Piece Referred to PGIT by [Redacted Name] for Analysis December 20, 1996.

Memorandum for Record from Director, Research and Technology, US Army Edgewood Research and Development Center, Subject: Analysis of Metal Scrap Final Report, December 12, 1995.

Memorandum, Subject: Analysis of Sample (Steel Fragment), MSIC, June 2, 1994.

PGIIT Status Report, Subject: SCUD Missile Part, no date.

Results of analysis, ERDEC analyst, October 13, 1995.

*Special Study of the 347th's Participation in Desert Shield/Desert Storm: January - December 1991*, Vol. 1, Ninth Air Force Air Combat Command, USAF.

USAF Message, Serial Number S/DQ/148-81, Defense Special Missile and Astronautics Center.

## ***TAB C - METHODOLOGY FOR CHEMICAL INCIDENT INVESTIGATION***

The DOD requires a common framework for our investigations and assessments of chemical warfare agent incident reports, so we turned to the United Nations and the international community which had experience concerning chemical weapons. Because the modern battlefield is complex, the international community developed investigation and validation protocols<sup>12</sup> to provide objective procedures for possible chemical weapons incidents. The standard that we are using is based on these protocols that include:

- A detailed written record of the conditions at the site.
- Physical evidence from the site such as weapons fragments, soil, water, vegetation, or human or animal tissue samples.
- A record of the chain of custody during transportation of the evidence.
- Testimony of eyewitnesses.
- Multiple analyses.
- Review of the evidence by an expert panel.

While the DOD methodology for investigating chemical incidents (Figure 2) is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Accordingly, the methodology is designed to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. The major efforts in this methodology are:

- Substantiate the incident.
- Document the medical reports related to the incident.
- Interview appropriate people.
- Obtain information available to external organizations.
- Assess the results.

Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

To substantiate the circumstances surrounding an incident, the investigator searches for documentation from operational, intelligence, and environmental logs. This focuses the investigation on a specific time, date, and location, clarifies the conditions under which the incident occurred, and determines whether there is "hard" as well as anecdotal evidence. Additionally, the investigator looks for physical evidence that might indicate that chemical

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<sup>12</sup> "Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction," April 29, 1997. This Chemical Weapons Convention was opened for signature in Paris, France, on January 13, 1993. It has been signed by 165 States and ratified by 93 States (as of June 1997.) It was signed by the U.S. on Jan 13, 1993 and ratified on April 25, 1997. Part XI of the Convention, "Investigations in Cases of Alleged Use of Chemical Weapons," details some of the procedures. [<http://www.unog.ch/frames/disarm/distreat/chemical.htm>]

agents were present in the vicinity of the incident, including samples (or the results of analyses of samples) collected at the time of the incident.

The investigator searches the medical records to determine if personnel were injured as a result of the incident. Deaths, injuries, sicknesses, etc. near the time and location of an incident may be telling. Medical experts should provide information about alleged chemical casualties.

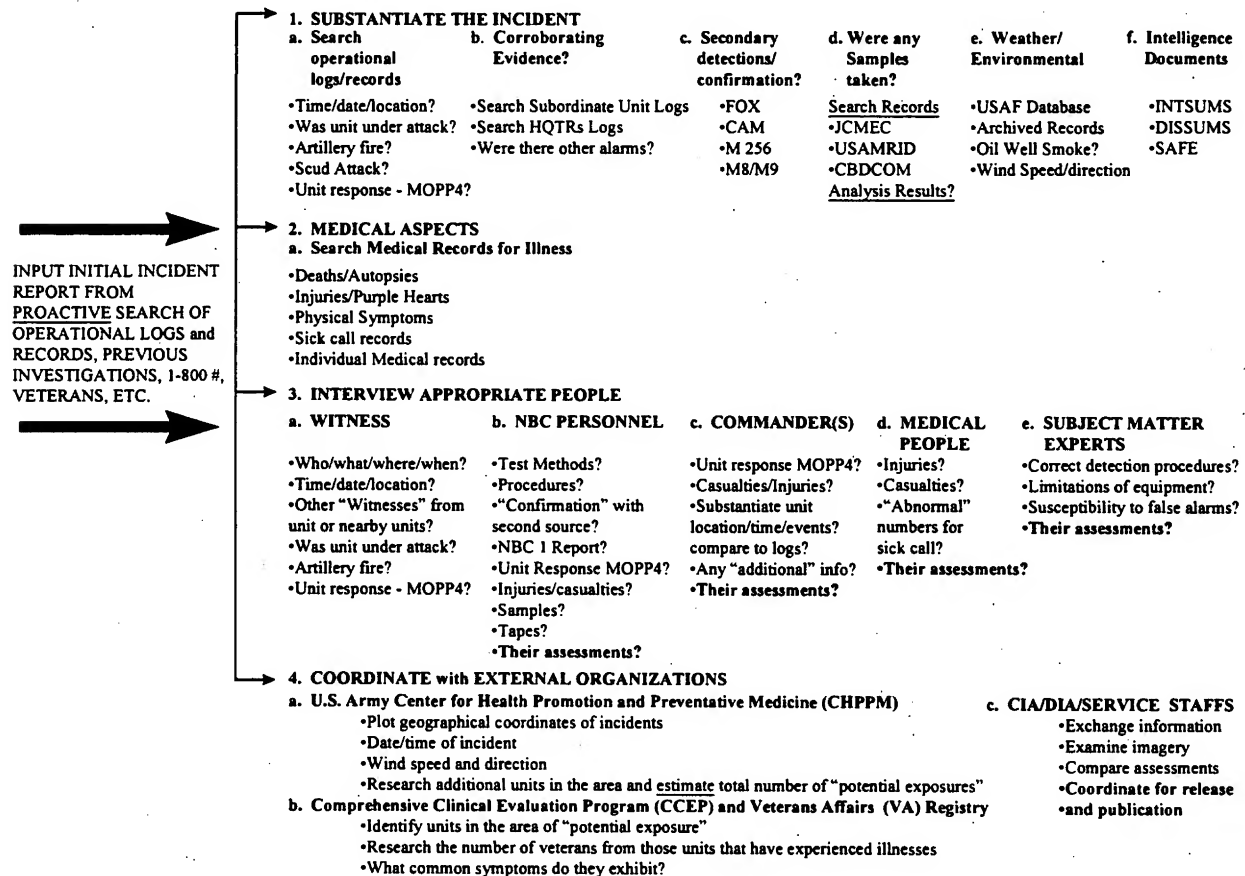


Figure 2. Chemical Incident Investigation Methodology

Interviews of incident victims (or direct observers) are conducted. First-hand witnesses provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved, and are particularly important if physical evidence is lacking. NBC officers or personnel trained in chemical and biological testing; confirmation, and reporting are interviewed to identify the unit's response, the tests that were run, the injuries sustained, and the reports submitted. Commanders are contacted to ascertain what they knew, what decisions they made concerning the events surrounding the incident, and their assessment of the incident. Where

Additionally, the investigator contacts agencies and organizations that may be able to provide additional clarifying information about the case. These would include, but not be limited to:

- Intelligence agencies that might be able to provide insight into events leading to the event, imagery of the area of the incident, and assessments of factors affecting the case.
- The DOD and Veterans' clinical registries, which may provide data about the medical condition of personnel involved in the incident.

# **Case Narrative**

## **Czech and French Reports of Possible Chemical Agent Detections**

Case narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on reports of possible chemical agent detections by Czech and French troops. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. Due to difficulty in obtaining evidence from the Czech and French governments, we would especially like to hear from anyone with personal knowledge of these incidents, i.e., people who were present at the time or who processed any of the reports that were generated as a result of these detections. With your help, we will be able to report more accurately on the events surrounding these possible chemical agent detections. Please contact my office to report any new information by calling:

**1-800-472-6719**

**Bernard Rostker**  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997322-0000-066

Last Update: July 29, 1998

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1995 to investigate all possible causes. On November 12, 1996, responsibility for these investigations was assumed by the Investigation and Analysis Directorate, Office of the Special Assistant for Gulf War Illnesses, which has continued to investigate reports of chemical agent detections by Czech and French troops.

As part of the effort to inform the public about the progress of this effort, DoD is publishing on the Internet and elsewhere accounts related to possible causes of illnesses among Gulf War veterans, along with whatever documentary evidence or personal testimony was used in compiling the account. The narrative that follows is such an account.

This narrative reflects only the opinion of the US Department of Defense. During a fact-finding trip to Paris and Prague in September 1997, the Special Assistant provided the governments of France and the Czech Republic a copy of this case narrative and requested official comments on the report. We are waiting for comments from the Czech and French governments; when those comments are received, the narrative will be updated.

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## METHODOLOGY

During and after the Gulf War, people reported that they had been exposed to chemical warfare agents. To investigate these incidents, and to determine if chemical weapons were used, the DoD developed a methodology for investigation and validation based on work done by the United Nations and the international community where the criteria include:

- A detailed written record of the conditions at the site
- Physical evidence from the site such as weapons fragments, soil, water, vegetation or human/animal tissue samples
- A record of the chain of custody during transportation of the evidence
- Testimony of eyewitnesses
- Multiple analyses
- Review of the evidence by experts.

While the DoD methodology (Tab C) for investigating chemical incidents is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence was often not collected at the time of an event. Therefore, we cannot apply a rigid template to all incidents, and each investigation must be tailored to its unique circumstances. Accordingly, we designed our methodology to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. Alarms alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence.

By following our methodology and accumulating anecdotal, documentary, and physical evidence, and by interviewing eyewitnesses and key personnel, and analyzing the results, the investigator can assess the validity of the presence of chemical warfare agents on the battlefield. Because information from various sources may be contradictory, we have developed an assessment scale (Figure 1) ranging from "Definitely" to "Definitely Not" with intermediate assessments of "Likely," "Unlikely," and "Indeterminate." This assessment is tentative, based on facts available as of the date of the report publication; each case is reassessed over time based on new information and feedback.

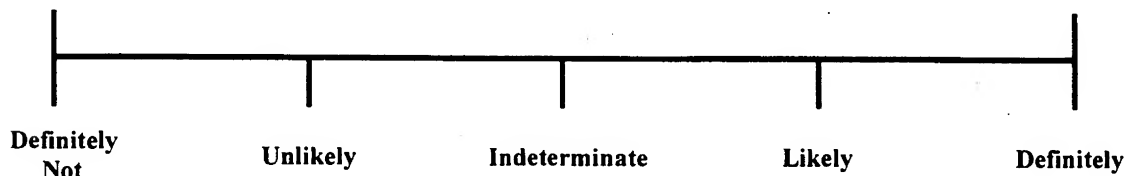


Figure 1. Assessment of Chemical Warfare Agent Presence

The standard for making the assessment is based on common sense: do the available facts lead a reasonable person to conclude that chemical warfare agents were or were not present? When insufficient information is available, the assessment is "Indeterminate" until more evidence can be found.

As mentioned above, this methodology is designed to be adapted to individual case requirements. In this particular case, the investigators were relying on information originally reported by members of the Coalition, specifically the nations of the Czech Republic and France. While investigating this case, the investigators needed to respect both France's and the Czech Republic's sovereign rights to protect their citizens' privacy and use established diplomatic channels to obtain answers to questions regarding these incidents. Due to these limitations investigators were not able to interview the Czech and French soldiers who had firsthand knowledge of these incidents. As a result of this unavoidable situation, many questions still remain.

## SUMMARY

During the first several days of the Air Campaign, Czech and French units reported as many as seven detections of nerve and blister agents in portions of the Operation Desert Storm Theater. These reported detections took place between January 19 and January 24, 1991, in the vicinities of Hafar al Batin and King Khalid Military City (KKMC), Saudi Arabia. Both the Czech and the French reports noted concentrations of chemical agents far below levels determined to be life threatening or able to cause immediate injury to troops in the area. The majority of those incidents were reported to each nation's respective chain of command, as well as to the Coalition headquarters at CENTCOM.

Czech units in the Gulf War reported four chemical agent detections. The Czech government, however, indicates that their troops had two chemical detections. A nerve agent detection that occurred near Hafar al Batin on January 19, 1991, and a report of discolored sand near KKMC on January 24, 1991. The United States cannot independently verify the Czech reports, however, the Department of Defense (DoD) is confident in the Czechs' ability to detect the presence of chemical agents. In November 1993, the DoD assessed these two detections as valid and during testimony to the Presidential Advisory Committee in 1996, the Central Intelligence Agency (CIA) publicly stated that these detections were credible. This determination was based on an in-depth analysis by US technical experts of the Czechs' technical competence and the reliability of the Czech equipment. Investigators have not found any additional evidence that would change DoD's and CIA's original assessment of detections.

The Czech government has not provided information about the remaining two reported detections. Investigators have relied on Gulf War-era logs and statements by personnel involved to gather information about these reported detections. The first of these reports involved a detection of Mustard vapor by a Czech unit near KKMC on January 19<sup>th</sup>. Although personnel involved reported the detection of Mustard agent by the CHP-71, a Czech chemical agent detector, they were unable to independently confirm the presence of Mustard using other detection protocols. Additionally, other confirmatory details, such as a more precise location of the detection, have not been discovered. Based on the lack of confirmatory tests and no obvious source for the chemical agents detected, as well as the fact that the Czech government has never indicated these detections occurred nor provided information about them, this detection has been assessed as "Indeterminate."

The second of the Czech detections, which was recorded in Gulf War logs but has not been acknowledged by the Czech government, occurred on January 20<sup>th</sup>. It involved a Czech unit, in direct support of the French, which detected the presence of Tabun and Sarin. An Intelligence Spot Report contained an entry reporting that on January 21<sup>st</sup> the French reported detecting Tabun, Sarin and Blister agents in their area. Although this report of the French detection does not specifically mention the presence of the Czechs, because the Czechs were reportedly in support of the French at the time of their detection, both of these reports are considered one incident. Other confirmatory details, such as a more precise location of the detection, were not provided in either log entry. Based on the lack of confirmatory tests and no obvious source for the chemical agents detected, as

well as the fact that neither the French nor the Czech governments have ever indicated these detections occurred nor provided additional information about them, these detections have been assessed as "Indeterminate."

The government of France has not provided information about any of the four reported chemical detections attributed to the French forces during the Gulf War. In addition, the French have never provided specifics about their chemical detection equipment. Without this information, it is difficult to assess the chemical detection capabilities and the technical competence of the French forces. Using Gulf War-era logs, interviews with US personnel involved, and defense periodicals, investigators have pieced together what little is known about these incidents.

The first incident involving French forces occurred on January 19, 1991. This report involved a very low-level nerve agent detection in the vicinity of KKMC. The reports indicate that the French were called in and confirmed the presence of the chemical agents. The second French incident also occurred on January 19<sup>th</sup>, and involved a report in the 18 Corps net (XVIII Airborne) in which the French reported "gas/gas/gas." The third incident is described above in conjunction with the Czech detection of Sarin and Tabun on January 20<sup>th</sup>. As discussed in the narrative, investigators believe all three of these French incidents as well as the Czech Sarin and Tabun detection on January 20<sup>th</sup> are reports of the same detections recorded through different channels. Due to the fact that the government of France has not acknowledged these detections and the Czech Republic has never mentioned confirming any French detections; as well as the lack of confirmatory information about these detections and the absence of a possible source, these detections are assessed as "Indeterminate."

The fourth French incident occurred between January 24-25, 1991. A US Senator who inquired into the possible causes of Gulf War illnesses was told that a low-level detection of nerve and blister agent occurred at a logistics facility outside of KKMC and was reported by a member of the French military. Despite an extensive effort, this investigation has not discovered any possible source for the chemical agents reportedly detected. Due to the overall lack of information about this reported detection, this incident is assessed as "Indeterminate."

## **NARRATIVE<sup>1</sup>**

### **Background**

Information about the Czech detections was first released to the public by the Czech press in July 1993. At first, the Czech Ministry of Defense denied these reports: "there is no record that the unit detected the presence of these substances."<sup>2</sup> Subsequently, however, on October 1, 1993, the Press Department of the Czech Ministry of Defense released a report detailing the events surrounding two detections of chemical agents by a

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<sup>1</sup> An acronym listing/glossary is at Tab A.

<sup>2</sup> "Defense Ministry Pours Doubt on Gulf War Illnesses Claims," FBIS AU0907193793.

Czechoslovak chemical detection unit on January 19, 1991, and January 24, 1991. The report stated that:

[d]uring the period in question, toxic dust concentrations of Yperite [Mustard] and Sarin chemical agents were detected several times around the Brigades, as well as in King Khalid Military City (i.e., within the military encampment in which the unit is billeted), probably as a result of allied air strikes against chemical munitions depots in Iraq.<sup>3</sup>

Information regarding possible French detections is very limited. Three reports of possible chemical detections by the French between January 19, 1991 and January 24, 1991, have been discovered in various US logs from the Gulf War.<sup>4</sup> The government of France has not released details of these detections or information pertaining to their troops' chemical detection capabilities. An assessment of the events surrounding the possible French detections and their chemical agent detection capabilities has been pieced together by reviewing information available in open source literature, various logs and journals kept by the US during Operation Desert Storm, and interviews with American veterans who had contact with the French.

During the war, US Central Command (CENTCOM) and other elements of the command structure were aware of the possible detections by the Czechs and the French. At the time, however, the reports were thought to be one of the many false positives reported, because the Czech equipment was "considered adequate for battlefield detection purposes but not capable of reliably detecting [the] 'sub-threshold/human effects' amounts of chemical agents"<sup>5</sup> that were reported. However, subsequent testing of the Czech detection equipment after the Gulf War confirmed that the Czech's possessed the capabilities to detect chemical warfare agents at the low levels reported.

### *Previous Investigations and Reports*

The United States Department of Defense (DoD) made its first public announcement acknowledging the Czech Ministry of Defense reports and the reported Czech chemical agent detections at a press conference on November 10, 1993. Then Secretary of Defense, Les Aspin, and Dr. John Deutch, then Under Secretary of Defense for Acquisition, "... present[ed] some preliminary findings on reports of the chemical agent detections during the Gulf War ...."<sup>6</sup> Secretary Aspin reported the following:

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<sup>3</sup> Czech Ministry of Defense Report, "The Czechoslovak Chemical Defense Unit in the Persian Gulf and Findings of the Investigation Concerning Possible Use of Combat Toxic Agents," September 1997. In October 1993, the Czech Ministry of Defense first released the report of "The Czechoslovak Chemical Defense Unit in the Persian Gulf and Findings of the Investigation Concerning Possible Use of Combat Toxic Agents." During the Special Assistant's visit to Prague in September 1997, the Czech Ministry of Defense provided him with this more current version of the official Czech Ministry of Defense Report.

<sup>4</sup> CENTCOM NBC logs, Daily Staff and Duty Officer Logs, etc.

<sup>5</sup> CENTCOM Log Investigation, CMAT 1998027-0000004, Prepared statement by CENTCOM NBC Watch Officer.

<sup>6</sup> US Department of Defense News Briefing, Washington, DC, November 10, 1993.

In October of this year interest in the Czech reports in Congress and elsewhere increased. A team of Defense Department Experts went to Prague to pursue the reports. The team assessed Czech training, equipment, technical competence, and procedures. Based on this assessment and an examination of the available records, team members concluded that the Czech detections [of Sarin on January 19<sup>th</sup> and Mustard on January 24<sup>th</sup>] were valid.

So where does that leave us? Still with some degree of uncertainty. The investigation team, which based its investigation on the professionalism and equipment of the Czech military, concluded that the detections were valid, but we cannot confirm the detections. That is, we have no physical evidence, no samples, and no confirming detections. In other words, nobody else reported these detections.

The Czechs found no physical evidence of offensive action by Iraqi forces that could account for it. There were no SCUD launches [or impacts], no artillery exchanges, or no offensive actions at this time in this area that could have delivered the chemical agents.<sup>7</sup>

The reports of the Czech and French detections prompted members of Congress to investigate further. The Senate Committee on Banking, Housing, and Urban Affairs, chaired by Senator Donald Riegle, was one of the first committees to start an investigation into possible chemical exposures during the Gulf War. As part of that investigation, Senator Richard Shelby, a member of the Committee, traveled to Europe in November and December 1993, and the Middle East in January 1994, to meet with representatives from the governments of the Gulf War Coalition. This included meeting with representatives from the Czech and French Ministries of Defense. At these meetings, Senator Shelby was provided with more detailed descriptions of the events surrounding both countries' reported chemical detection incidents.

Upon returning from his visits to the Coalition nations, Senator Shelby informed the Senate and the Committee on Banking, Housing, and Urban Affairs of his findings. Senator Shelby produced a report for the committee that was released on March 17, 1994. (This report titled *Senator Shelby's Conclusions on Persian Gulf Syndrome* will be referred to as the Shelby report throughout this narrative.) As a result of Senator Shelby's findings and those from other investigations conducted by members of the committee and their staffs, the Senate Committee on Banking, Housing, and Urban Affairs released a report on May 25, 1994, titled *US Chemical and Biological Warfare-Related Dual Use Exports to Iraq and their Possible Impact on the Health Consequences of the Persian Gulf War*. (This report will be referred to as the Riegle report throughout this narrative.) The Shelby and Riegle reports highlighted the facts that they had gathered during their investigations. Conclusions about the reported Czech and French chemical detections were not drawn in either of the reports.

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<sup>7</sup> US Department of Defense News Briefing, Washington, DC, November 10, 1993.

In addition to the Shelby and Riegle reports, other Congressional committees, as well as the Presidential Advisory Committee on Gulf War Veterans' Illnesses, conducted investigations into the Czech and French detections. Information contained in these reports and hearings were also used for this case narrative.

The DoD, reacting to growing concern over the health of veterans who served in the Gulf, requested that the Defense Science Board<sup>8</sup> (DSB), "establish a ... Task Force regarding the possible exposure of personnel to chemical and biological weapons agents and other hazardous material during the Gulf War and its aftermath."<sup>9</sup> The DSB task force's final report, released in June 1994, acknowledged the fact that both the Czech and the French units reported detections of chemical agents during the Gulf War.<sup>10</sup>

On August 5, 1995, the Persian Gulf Illnesses Investigation Team (PGIIT), the predecessor to the Investigations and Analysis Directorate, Office of the Special Assistant for Gulf War Illnesses, published a report that highlighted the chemical detections of the Czech and French units during the Gulf War. The PGIIT report<sup>11</sup> was a summary of the previous investigations (described above), including the DSB Report, the Shelby Report, and the Riegle Report.<sup>12</sup> The PGIIT report was not based on any new investigation or analysis.

When the Investigation and Analysis Directorate assumed responsibility for investigating possible exposures to chemical agents during Operation Desert Storm, the Special Assistant decided to further investigate the incidents reported by both the Czech and the French troops. The purpose of the reinvestigation was to determine if there were any additional facts that could confirm the reported detections by the Czech and the French or further explain the information previously reported.

### *Current Investigation*

This investigation reviewed primary source information, where available, relating to the reported Czech and French detections, interviewed US personnel who were thought to have pertinent information about the reported detections, analyzed information contained in the various reports mentioned earlier, and coordinated investigative efforts with other US government agencies. While investigating this case, the investigators needed to respect both France's and the Czech Republic's sovereign rights to protect their citizens' privacy and use established diplomatic channels to obtain answers to questions regarding

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<sup>8</sup> The Defense Science Board is a Federal Advisory Committee established to provide independent advice to the Secretary of Defense.

<sup>9</sup> Lederberg, Joshua, "Report of the Defense Science Board Task Force on Persian Gulf War Health Effects," June 1994, *Terms of Reference*.

<sup>10</sup> Lederberg, Joshua, "Report of the Defense Science Board Task Force on Persian Gulf War Health Effects," June 1994.

<sup>11</sup> PGIIT Report, *Coalition Chemical Detections and Health of Coalition Troops in Detection Area*. August 5, 1996.

<sup>12</sup> US Department of Defense News Briefing, Washington, DC, August 22, 1996.

these incidents. Due to these limitations, investigators were not able to interview the Czech and French soldiers who had firsthand knowledge of these incidents. For the Czech detections, investigators also had the opportunity to analyze information provided by the Czech Ministry of Defense. To date, the government of France has not provided information regarding their reported detections. For this reason, much less data was available for analysis regarding the French reports of chemical agent detections.

In addition to these investigative efforts, between September 8 and 20, 1997, the Special Assistant and other representatives from his office and Congress met with officials from the Czech and French Ministries of Defense to discuss the reported detections, as well as other Gulf War-related issues. While in Paris, France, and Prague, Czech Republic, the Special Assistant provided both governments with a draft copy of the case narrative<sup>13</sup> and requested an official government response. To date, those responses have not been received. When the official government responses are received, this narrative will be updated to reflect their comments.

Currently, this case narrative reflects the opinion of the United States Department of Defense and presents the facts, as they are currently understood, surrounding the possible detections by the Czech and French troops.

### **Czech Forces**

The chemical forces from the Czech and Slovak Republic (referred to as the Czechs) that served in the Gulf were under contract to the Saudi government to provide chemical weapons/agent detection to the Saudi government during the Persian Gulf War.<sup>14</sup> The Saudis sought to hire the Czechs because they did not have sufficient personnel trained in NBC defense.<sup>15</sup> The following is an excerpt of the agreement between Saudi Arabia and the Czech Republic:

A unit of Czechoslovak military specialists comprising [sic] of 169 persons was sent to the Gulf as a result of an agreement between the government of the Czech and Slovak Republic (CSFR) and the government of the Kingdom of Saudi Arabia (KSA) regarding the function and conditions of Czechoslovak military specialists in the area of the Kingdom of Saudi Arabia. The agreement was signed in Prague on November 19, 1990, and amended in Riyadh on November 22, 1990 ....

As a result of an operational order of the Northern area commander of the [Department of Defense] DOD of the Kingdom of Saudi Arabia, the unit

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<sup>13</sup> Memorandum for Deputy Secretary of Defense from Bernard Rostker, Special Assistant for Gulf War Illnesses. "Office of the Special Assistant for Gulf War Illnesses Trip Report Information Memorandum." October 1997.

<sup>14</sup> Memorandum to Senator Nunn and Senator Thurmond from Senator Shelby, Subject: Report on trip to investigate 'Persian Gulf Syndrome.' March 17, 1994.

<sup>15</sup> CENTCOM NBC Log Investigation, Interview with CENTCOM NBC Watch Officer. January 21, 1997. CMAT #1998027-0000004.



was incorporated into the order of that region on December 22 .... On January 1, 1991, the two chemical battalions were incorporated into the order of the 4<sup>th</sup> and 20<sup>th</sup> brigade of the KSA military. The rest of the unit was deployed at the basic camp with the staff.

Deployment and strategic control of the unit was fully within the competency of Saudi Arabia. The concrete means of completing tasks was decided by the unit commander... whose duty was to make sure that the valid Czechoslovak legal order and basic standards of international law were not violated while completing the tasks.

The Czechoslovak chemical unit was mainly carrying out these tasks:

1. Chemical support of the HQ of the Northern area and troops deployed in the area of the King Khalid Military City
2. Chemical support of the 4<sup>th</sup> and 20<sup>th</sup> brigade of the Kingdom of Saudi Arabia
3. In case of toxic agents used against personnel to deploy a personnel decontamination site for them.<sup>16</sup>

Of the 169 Czech troops sent to the Gulf, 56 were career chemical defense specialists with the Czech military. They were all graduates of military post-secondary schools in the chemical defense branch. The chemical specialists worked with selected toxic agents both in the laboratory, as well as at chemical defense training facilities. The Czech chemical detection personnel were highly trained chemical specialists.<sup>17</sup>

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<sup>16</sup> Czech Ministry of Defense Report, "The Czechoslovak Chemical Defense Unit in the Persian Gulf and Findings of the Investigation Concerning Possible Use of Combat Toxic Agents," September 1997.

<sup>17</sup> Czech Ministry of Defense Report, "The Czechoslovak Chemical Defense Unit in the Persian Gulf and Findings of the Investigation Concerning Possible Use of Combat Toxic Agents," September 1997.

## Czech Chemical Detection Equipment<sup>18</sup>

The Czech chemical unit brought its own advanced detection equipment with them to the gulf:

The unit had available to it all modern means of chemical monitoring. This chemical defense equipment is capable of detecting threshold sensitivities (levels not interfering with normal human activity) of the anticipated toxic agents, and it enables differentiation between Sarin nerve agent and V-type agents.<sup>19</sup>

The Czech units in the Gulf were equipped with the GSP-11 automatic nerve agent detector alarm, the CHP-71 chemical agent detector, the PCHL-90 field portable chemical laboratory and a truck-mounted mobile laboratory. The available literature about the Czech equipment is limited, however it provides a summary of the chemical detection capabilities available to the Czech specialists.<sup>20</sup>

### *GSP-11 Automatic Nerve Agent Detector Alarm*

The GSP-11 uses a photodetector to detect a color change on a tape that has been treated with a reagent. Nerve agent sets off both an audible and a visible alarm. The GSP-11 uses biochemical reaction (acetylcholinesterase inhibition) chemistry. Consequently, it can detect both V-type nerve agents and G-type nerve agents, including GA (Tabun), GB (Sarin), GD (Soman), GF (Cyclosarin) and VF. The chemical reactions in the GSP-11 are temperature sensitive, and the device has a thermostatically controlled electric heater that maintains a constant temperature between +33 and +38 degrees Centigrade (91.4 and 100.4 degrees Fahrenheit). Operating the device outside the range of -30 to +40 degrees Centigrade (-22 to 104 degrees Fahrenheit) may cause the alarm to cease functioning or give a false alarm. The GSP-11 may be used for fixed-point continuous air monitoring or it may be mounted in reconnaissance vehicles. If nerve agents are detected, a second equipment set, the CHP-71, is used to identify the specific agent and its concentration.<sup>21</sup>

The GSP-11 has two sensitivity ranges (0.05 mg/m<sup>3</sup> and 0.005 mg/m<sup>3</sup>). At the more sensitive setting, test samples are taken at intervals of 60 to 80 seconds. Each test cycle lasts between 22 and 26 seconds. Airflow through the system is between 0.7 and 1.0 liter/minute. This setting allows the GSP-11 to remain in operation for two hours on one

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<sup>18</sup> For more detailed descriptions about the Czech detection equipment see Tab D.

<sup>19</sup> Czech Ministry of Defense Report, "The Czechoslovak Chemical Defense Unit in the Persian Gulf and Findings of the Investigation Concerning Possible Use of Combat Toxic Agents," September, 1997.

<sup>20</sup> A technical description of the Czech and French equipment is located in Tab D.

<sup>21</sup> Chemical and Biological Defense Information Analysis Center, Worldwide Chemical Detection Equipment Handbook, Aberdeen Proving Grounds, Maryland, October 1995, p. 76-78. "Copies of the Worldwide Chemical Detection Handbook, may be purchased from the CBIAC. To order, please contact Judi Shetterly, CBIAC Administrator, via phone (410-676-9030), fax (410-676-9703), e-mail ([cbiac@battelle.org](mailto:cbiac@battelle.org)), or use the interactive form on the CBIAC website (<http://www.cbic.apgea.army.mil/>)."

reagent filling. At the less sensitive setting, test samples are taken at intervals of 5 to 8 minutes. Each test cycle lasts between 1.5 and 2.5 minutes. Airflow is reduced to 0.5 to 0.7 liter/minute. At this lower sensitivity setting, the unit can remain operational on one reagent filling for 10 to 12 hours.<sup>22</sup>

### ***CHP-71 Chemical Agent Detector***

The CHP-71 chemical agent detector is a lightweight, portable instrument used for the point detection of chemical agents in the air, on terrain, and on the surface of military equipment. A built-in motorized pump draws an air sample at 3 liters/minute into the unit and through the detector tubes. To identify chemical agents, color changes in the detector tubes are compared to a standard color chart for the identification of the chemical agent. The color can also indicate the concentration level of the toxic agent identified. If the CHP-71 is mounted in a vehicle and running off the vehicle power supply, it has an unlimited operational time. If it is running off its own batteries, the unit can operate at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) for six hours on one battery kit. The CHP-71 can detect GB, GD and V-type nerve agents, blister agents (H), and other chemical warfare agents. It is capable of detecting nerve agents at levels of 0.0005 mg/m<sup>3</sup> and blister agents at a level of 1 mg/m<sup>3</sup>. High concentrations of Ammonia (NH<sub>3</sub>), Sulfur dioxide (SO<sub>2</sub>), or Chlorine (CL<sub>2</sub>) can trigger false positive readings.<sup>23</sup>

### ***PCHL-90 Portable Chemical Laboratory***

The PCHL-90 is a portable unit containing chemical reagents and appropriate laboratory equipment. It is designed to detect, under field conditions, the presence of chemical agents on contaminated equipment, uniforms, clothing, terrain, water, food, animal feed, and various materials. The PCHL-90 can also detect residual contamination and the effectiveness of decontaminating solutions and mixtures containing active chlorine. Visible color changes from chemical reactions indicate agent detection. The PCHL-90 is intended for rapid quantitative and semi-qualitative analysis of toxic substances like organophosphorus-based chemical warfare agents, herbicides, alkaloids and others. It checks the decontamination of materials, objects and terrain, as well as solutions and mixtures that contain active chlorine, and analyzes any undefined samples. The kit can detect GB, GD, and VX nerve agents, H blister agents, and other agent classes. Sensitivity for GB and GD is 0.005 mg/m<sup>3</sup> in air, 1 mg/liter in water, and .005 mg/m<sup>2</sup> on surfaces. Sensitivity for H is 5 mg/m<sup>3</sup>.<sup>24</sup>

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<sup>22</sup> Gander, T.J., ed., "Jane's NBC Protection Equipment 94," Eighth Edition, 1995-1996, Surry, UK, 1995, p. 144.

<sup>23</sup> Chemical and Biological Defense Information Analysis Center, Worldwide Chemical Detection Equipment Handbook, Aberdeen Proving Grounds, Maryland, October 1995, p. 94-95.

<sup>24</sup> Chemical and Biological Defense Information Analysis Center, Worldwide Chemical Detection Equipment Handbook, Aberdeen Proving Grounds, Maryland, October 1995, p. 106-107.

### ***Truck Mounted Mobile Laboratory***

A detailed description of the Czech truck-mounted mobile laboratory's capabilities is not currently available; however, the Defense Intelligence Agency (DIA) described the mobile laboratory as "a basic but well-equipped unit with a good capability to classify chemical warfare agents, although not able to identify specific agents at very low levels." Since tests conducted in this laboratory were destructive to the sample tested, a small quantity of sample might not have supported a complete test. The amount of sample the Czechs collected for the nerve and blister agent detections is unknown. Therefore, it is impossible to determine the completeness of the tests conducted by the truck mounted mobile laboratory.<sup>25</sup>

### **French Forces**

The core of the French ground forces deployed to the Gulf came from a special force called the Force d'Action Rapide (FAR). The key element of this force included the 6<sup>th</sup> Light Armored Division reinforced with additional airmobile and other assets. Along with the FAR, the French also deployed elements of the 9<sup>th</sup> Marine Division; including the 2<sup>nd</sup> Marine Infantry Regiment, a 269-man detachment of the 3<sup>rd</sup> Marine Regiment, and the 11<sup>th</sup> Marine Regiment. The total French ground force in the Gulf included about 9,000 personnel. The French airmobile and anti-armor capabilities were primarily used in the long-range thrust securing the Coalition's western flank ahead of the XVIII Corps.<sup>26</sup> While it is known that the French troops possessed some chemical detection equipment, it is understood that France did not deploy any chemical specialists to the Gulf. The assumption is that personnel in the French units were trained in the operation of the detection equipment, but that was not their primary area of expertise.

Unlike the Czech forces, French forces in the theater remained under French command, but maintained a coordinating relationship with the Commander of the Joint Forces-Theater of Operations. The French 6<sup>th</sup> Light Armored Division was placed under the tactical control of the US Army Central Command (ARCENT), where it operated as a unit of the XVIII Airborne Corps.<sup>27</sup> The "French forces worked closely with the 2<sup>nd</sup> brigade of the 82<sup>nd</sup> US Airborne Division, obtained extensive fire support from the 18<sup>th</sup> US Army artillery brigade and obtained occasional close air support from the US Air Force."<sup>28</sup>

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<sup>25</sup> Defense Intelligence Agency message 021952Z, Subject: Czech Republic: Gulf War Chemical Agent Detections, August 1994.

<sup>26</sup> Cordesman, Anthony H. and Abraham R. Wagner, "The Gulf War," The Lessons of Modern War, Volume IV, 1996, p. 168-170.

<sup>27</sup> Department of Defense, Final Report to Congress, "Title V Report: Conduct of the Persian Gulf War," April 1994, p. 500.

<sup>28</sup> Cordesman, Anthony H. and Abraham R. Wagner, "The Gulf War," The Lessons of Modern War, Volume IV, 1996, p. 168-170.

## French Chemical Detection Equipment<sup>29</sup>

The French government has not disclosed the specific chemical detection equipment and methodologies used by French forces during the Gulf War. The United States DoD has requested this information, but, to date, no response has been received. When this information becomes available it will be posted in an update to this narrative.

Without information from the French, investigators used military equipment reference books, such as *Jane's NBC Protection Equipment* and the *Worldwide Chemical Detection Equipment Handbook*, to understand pieces of equipment that are normally contained in their inventory. These books have identified the APACC and the TDCC Chemical Detection Control Kit as the standard chemical detection devices used by French ground forces. This is supported, in part, by a manufacturer's brochure that claims that the AP2C, part of the APACC, was used during the Gulf War.<sup>30</sup>

### *APACC Chemical Control Alarm Portable Apparatus*

The APACC can detect the presence of both nerve and blister agents. It is comprised of the AP2C and an ADAC alarm. The presence of a chemical agent activates both an audible and visible alarm. In its portable configuration the APACC can be hand-held, placed on the ground, or vehicle mounted. The AP2C is designed to detect and monitor for the presence of elemental phosphorus and sulfur in a given air sample. Consequently, it is used to detect nerve agents (organophosphorus compounds) and Mustard agents (sulfur compounds) in the atmosphere. To detect liquid contamination, a special sampling tip is used to collect the sample. The sample is then heated to turn any contamination into a vapor form. The AP2C can detect G-agents at concentrations of 0.01 mg/m<sup>3</sup> within two seconds, and H-agents at concentrations of 0.4 mg/m<sup>3</sup> within two seconds. Sulfurated fuel smokes can provide inaccurate readings and false alarms.<sup>31</sup>

### *TDCC Chemical Detection Control Kit*

The TDCC can detect and identify chemical agent vapors in the air and liquid contamination in water and on various surfaces. A hand pump draws a constant volume of ambient air through an absorbent paper disc mounted on the pump. Toxic agents adhering to the paper are identified after exposure to one or more of eight reagents from the kit. The reagents produce a color change that is specific to each type of chemical agent. Detection papers from the kit are used to identify liquid contamination. The TDCC can detect blister agents down to concentrations of 0.15-1.0 mg/m<sup>3</sup> and nerve agents (GA and GB) down to 0.001 mg/m<sup>3</sup>.<sup>32</sup>

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<sup>29</sup> For more detailed descriptions about the French detection equipment see Tab D.

<sup>30</sup> Chemical and Biological Defense Information Analysis Center, *Worldwide Chemical Detection Equipment Handbook*, Aberdeen Proving Grounds, Maryland, October 1995, p. 149 and 171.

<sup>31</sup> Chemical and Biological Defense Information Analysis Center, *Worldwide Chemical Detection Equipment Handbook*, Aberdeen Proving Grounds, Maryland, October 1995, p. 148-149.

<sup>32</sup> Chemical and Biological Defense Information Analysis Center, *Worldwide Chemical Detection Equipment Handbook*, Aberdeen Proving Grounds, Maryland, October 1995, p. 162-163.

## Comparative Sensitivity Thresholds

Figure 2 shows the comparative sensitivities of the chemical detection equipment used by the United States, France, and Czechoslovakia in the Gulf War. The sensitivity of a chemical agent detector is determined by how high the concentration of agent must be in the sample before the detector will indicate the presence of chemical agents. A detector that requires a lower concentration of agent to alarm is said to have a low threshold. The lower the threshold, the more sensitive the equipment.

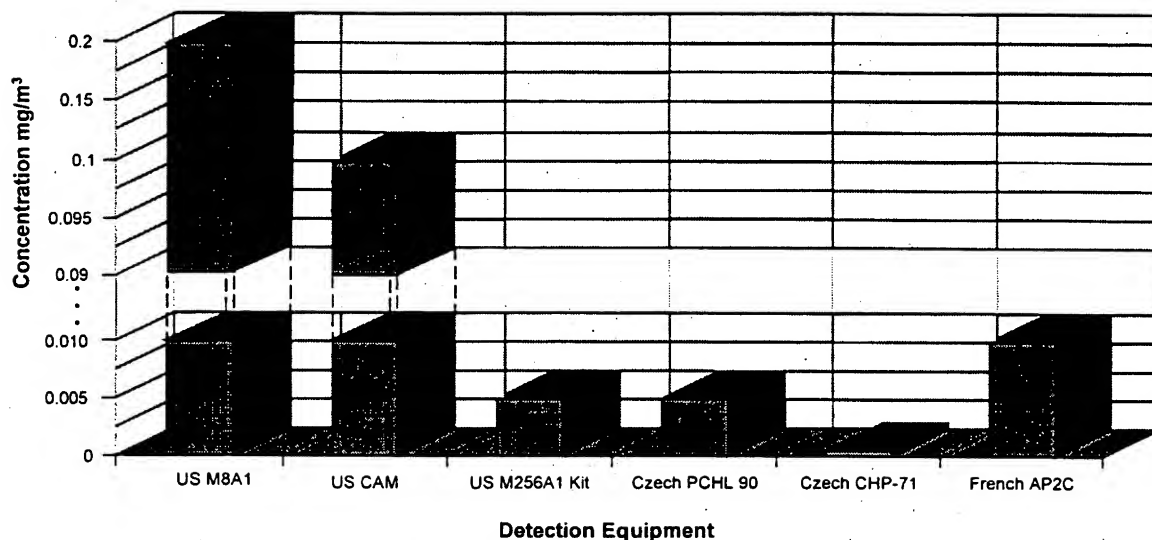


Figure 2. Chemical Detector Sensitivity Thresholds to G-Series Nerve Agents (Air)

Since most US detectors are less sensitive<sup>33</sup> than the Czech and possibly less sensitive than French detectors discussed above, they might be unable, in certain cases, to detect or confirm the presence of low (below casualty thresholds) levels of chemical agents. Unlike the Czech detectors, US equipment was designed to detect concentrations of chemical agents that pose a direct and immediate threat to a soldier's health.<sup>34</sup> It is important to note that the Czech CHP-71 and the US M256A1 Kit are equally as sensitive when testing for the presence of Mustard. The sensitivity threshold for both pieces of detection equipment for Mustard agent is approximately 1 mg/l<sup>3</sup>.

## Czech and French Reported Chemical Agent Detections

On January 17, 1991, the Coalition forces began the Air Campaign with extensive attacks on targets in Iraq. Some of the facilities that were targeted during the early phases of the

<sup>33</sup> The US M256A1 Kit is as sensitive as some of the Czech equipment; however, it is more susceptible to false positives.

<sup>34</sup> Ember, Louis R., "Chemical Warfare Agent Detectors Probe the Fogs of War," Chemical and Engineering News&EN, August 1, 1994, p. 26-32.

Air Campaign were suspected chemical and biological agent production plants and chemical weapon and biological weapon storage bunkers.<sup>35</sup>

Two days after the start of the Air Campaign, Czech and French units began reporting several possible detections of chemical agents. The chemical agents were detected in the vicinities of Hafar al Batin and King Khalid Military City (KKMC) from January 19 to January 24, 1991.

The following sections of this narrative describe the reported detections, and provide analyses of each reported incident. Table 1 contains a brief summary of both the Czech and the French reports of chemical detections. The descriptions of the chemical incidents are derived from the Ministry of Defense Report of the Czech Republic, CENTCOM NBC logs, unit logs and other available miscellaneous sources.

Table 1. Czech and French Reported Chemical Agent Detections

Date	Reporting Country	Type of Agent Detected	Location
January 19, 1991	Czech Republic	Sarin	North and Northwest of Hafar Al Batin
January 19, 1991	Czech Republic	Mustard	KKMC
January 19 or 20, 1991	France	Nerve and Blister	Approximately 30 km from KKMC
January 20 or 21, 1991	Czech Republic and France	Nerve Agent	Unknown location
January 21, 1991	France	Nerve and Blister	KKMC Area
January 24, 1991	Czech Republic	Blister	North of KKMC
January 24 or 25, 1991	France	Nerve and Mustard	South of KKMC

The Ministry of Defense of the Czech Republic has acknowledged two detections; the January 19, 1991, detection of Sarin at Hafar al Batin and the detection of Mustard agent outside of KKMC on January 24, 1991.<sup>36</sup> Due to the processes used to detect the chemical agents, the United States DoD and the Intelligence Community has labeled these two Czech detections as "valid" or "credible," however, other Coalition forces' attempts to verify detections were not successful.<sup>37</sup> The government of France has not

<sup>35</sup> US Central Command (CENTCOM) News Briefing, Riyadh, Saudi Arabia, February 4, 1991.

<sup>36</sup> Memorandum for Deputy Secretary of Defense from Bernard Rostker, Special Assistant for Gulf War Illnesses. "Office of the Special Assistant for Gulf War Illnesses Trip Report Information Memorandum." October 1997.

<sup>37</sup> US Department of Defense News Briefing, Washington, DC, November 10, 1993.

released any information regarding their reported detections; when this information becomes available it will be incorporated into an update of this case narrative.

### *Incident 1 - Czech Sarin Detection January 19, 1991*

In the morning to early-afternoon on January 19, 1991, two Czech units, one unit supporting the 4<sup>th</sup> Saudi brigade and one supporting the 20<sup>th</sup> Saudi brigade, reported low level nerve agent detections. At the time of the detections, the Czech unit supporting the 4<sup>th</sup> brigade was on convoy and was divided into two detachments separated by approximately two kilometers. The two detachments reported almost simultaneous detections at their locations about 37 kilometers northwest of Hafar Al Batin and 40 kilometers from the Iraqi border.<sup>38</sup> (Figure 3) According to the Czechs, about 30 minutes after the detections by the detachments supporting the 4<sup>th</sup> brigade, the unit supporting the 20<sup>th</sup> Saudi brigade reported a nerve agent detection approximately 45 kilometers northeast of Hafar Al Batin and 40 kilometers from the Kuwaiti border.<sup>39</sup> The Czech Republic considers all three of these detections to be "one event".<sup>40</sup>

Using their automatic nerve agent detectors in the semi-continuous mode, both Czech units detected the initial presence of nerve agent. The concentration of Sarin in the air sample was determined to be between 0.05 and 0.005 milligrams per cubic meter (low levels of chemical agent). Subsequently, in all three incidents, the troops donned their protective gear and conducted follow up tests using their CHP-71. The follow up tests also indicated the presence of nerve agent.<sup>41</sup> Because both the automatic nerve agent detector and the CHP-71 are based on the same biochemical principles, the CHP-71 raised the confidence of the initial alert but did not confirm the results of the automatic nerve agent detector. At least one of the Czech units collected an air sample<sup>42</sup> on a dried silica gel substrate for further testing at their mobile chemical laboratory in KKMC. There, it was determined that the sample contained the nerve agent Sarin (GB).<sup>43</sup>

At the time of the detections, the Czechs observed no SCUD missile launches or impacts, artillery attacks, or other events that would suggest Iraq was firing chemical weapons. The Czechs also did not see any of the symptoms that are typically associated with chemical agent exposure, such as eye, nose or breathing problems. It is not surprising that Czech personnel did not exhibit symptoms of chemical exposure, because the detection levels reported by the Czechs were below the levels that would cause these

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<sup>38</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>39</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>40</sup> Congressional Record, "Senator Shelby's Conclusions on the Persian Gulf Syndrome," Report to the 103<sup>rd</sup> Congress, March 17, 1991, p. S3100.

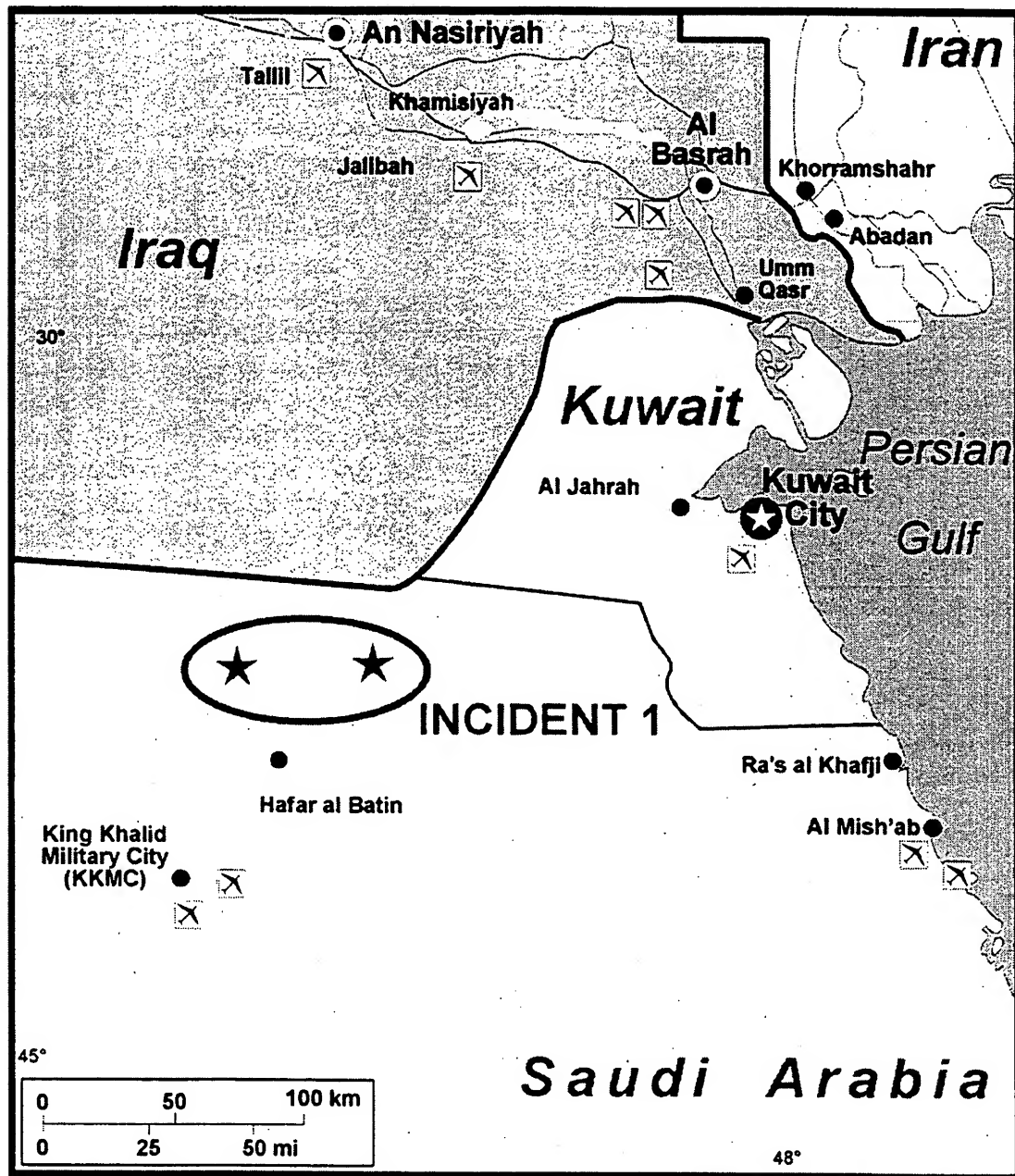
<sup>41</sup> The CHP-71 could register a positive result for any cholinesterase inhibiting organophosphate compound, which includes many agricultural insecticides.

<sup>42</sup> The Shelby report mentions that both units collected an air sample

<sup>43</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.



symptoms to appear. Furthermore, no other units in the area reported chemical agent detections, however, again the levels reported by the Czechs were below the sensitivity thresholds of other Coalition detection equipment.<sup>44,45</sup>



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Figure 3. Kuwaiti Theater of Operations with Incident 1, January 19, 1991

<sup>44</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>45</sup> Department of Defense Intelligence Document, December 19, 1997. CMAT #1997357-0000038.

The Czechs reported these detections through the brigade headquarters to the joint command in KKMC. A situation report was filed for the detections and forwarded through the Saudi military to Riyadh.<sup>46</sup> When CENTCOM received this information, US chemical specialists were sent to the area to conduct additional chemical agent testing and analysis. It is estimated that four hours elapsed between the initial Czech detections and the arrival of the US specialists. The US chemical team was not able to confirm the Czech detections. Given the non-persistent nature of Sarin, the amount of time that had elapsed, the low levels detected, and the apparent localized nature of the chemicals, DIA determined that the results of the US chemical team were not surprising.<sup>47</sup> The CENTCOM NBC logs do not note the report of this chemical detection.

### *Analysis of Incident 1*

Former Secretary of Defense Les Aspin characterized this incident as valid<sup>48</sup> and members of PGIIT and the Central Intelligence Agency (CIA) called it credible.<sup>49</sup> Their assessments were based on the known capabilities of the Czech chemical detection equipment, as well as the known processes used by the Czech personnel. The US has been unable to confirm these detections with US equipment and no air samples were saved for further testing. The Czech personnel used two different pieces of detection equipment (the CHP-71 and the mobile lab) that were based on different biochemical principles. The automatic nerve agent detector and the CHP-71 were used for the initial detection. In addition, the sample collected and taken to the mobile lab further corroborated the results of the initial field tests.

At the time that these detections were reported, it was thought that fallout from Coalition bombing of chemical weapons production and storage facilities in Iraq may have been the source of the chemical agent.<sup>50</sup> During the Gulf War, the Deputy Chemical Officer for Army Central Command (ARCENT) and the ARCENT Weather Officer looked into the fallout theory as a possible explanation for these detections. After plotting the winds for the days in question, both officers concluded that the fallout explanation "just didn't add up."<sup>51</sup>

Although the idea of chemical fallout was dismissed as a possible source for these detections during the war, the idea was revisited after the war. As a result of in-depth modeling analysis, the Intelligence Community also concluded that fallout from bombed Iraqi facilities was not the cause of the Czech nerve vapor detections near Hafar al Batin. This assessment was based on the extensive dispersion that would have been expected

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<sup>46</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>47</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>48</sup> US Department of Defense News Briefing, Washington, DC November 10, 1993.

<sup>49</sup> Testimony of LTC Jimmy E. Martin, PGIIT, and Ms. Sylvia L. Copeland, Central Intelligence Agency, before the Presidential Advisory Committee, May 1, 1996.

<sup>50</sup> Department of Defense Intelligence Document, December 19, 1997. CMAT #1997357-0000038.

<sup>51</sup> Interview with Deputy Chemical Officer for ARCENT, Lead ID 5319, April 7, 1997.

between Iraqi chemical facilities and the locations of this detection and the modeling of weather conditions that included rain and southerly winds on January 17<sup>th</sup> and 18<sup>th</sup>. The weather modeling, combined with a lack of Iraqi casualties that would have been expected from a release large enough to cause the Czech detection, formed the basis of the Intelligence Community's assessment.<sup>52</sup> However, a former staff member of the Senate's Committee on Banking, Housing, and Urban offered an alternative theory. In a report, the staff member postulated that the "winds aloft" rather than surface winds, trapped fallout from the bombing of Iraqi chemical sites and carried the chemicals to the locations of the detections. Although this claim cannot be fully accepted nor rejected, the staff member's analysis is based on releases occurring during the early morning hours on the day of the detections.<sup>53</sup> However, this investigation has discovered no releases from chemical facilities on the dates of the Czech and French detections. This investigation's analysis is explained in the following paragraphs and more information will be published in a separate information paper titled *The Air Campaign*.

After the war, Iraq claimed that only five percent of the approximately 700 metric tons of its declared chemical agent stockpile was actually destroyed by Coalition bombing. Coalition bombing did not cause more extensive damage to Iraq's chemical stockpile because, in many cases, the Iraqis did not store chemical munitions in bunkers that they believed would be targeted by the Coalition. Instead, the chemical weapons were often stored in open areas in the desert that were not generally targeted by Coalition forces. According to a CIA study, by the start of the Air Campaign, the Iraqis had also shut down or dismantled the majority of their chemical weapon and precursor production lines.<sup>54</sup>

A total of four known Iraqi munitions facilities that were struck by Coalition bombs, all considerably distant from Hafar Al Batin (Figure 4), have been identified as having contained filled chemical munitions. The facilities are An Nasiriyah, Muhammadiyat, Al Muthanna (also known as Samarra), and Ukhaydir. After reviewing raw intelligence and damage assessments from Coalition bombings in the seven years since the war, the CIA has concluded that Coalition bombing caused damage at Muhammadiyat, Al Muthanna, and Ukhaydir that could have released chemical agent.<sup>55,56</sup> Chemical munitions were also identified as being stored at An Nasiriyah during the first Coalition bombing, but no munitions were damaged as a result.<sup>57</sup> More information about the bombings of these facilities and the resulting damage will be published in forthcoming case narratives.

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<sup>52</sup> Defense Intelligence Agency, "Chemical and Biological Warfare in Desert Storm." April 1994.

<sup>53</sup> Tuite, James J., Report on the Fallout from the Destruction of the Iraqi Chemical Research, Production and Storage Facilities into Areas Occupied by US Military Personnel During the 1991 Persian Gulf War. 1996.

<sup>54</sup> Central Intelligence Agency, "CIA Report on Intelligence Related to Gulf War Illnesses," August 2, 1996.

<sup>55</sup> Central Intelligence Agency, "CIA Report on Intelligence Related to Gulf War Illnesses," August 2, 1996.

<sup>56</sup> Central Intelligence Agency, "Update on Potential Mustard Agent Release at Ukhaydir Ammunition Storage Depot." September 4, 1997.

<sup>57</sup> Department of Defense, "IIR 6 021 0196 96 Iraqi Fallujah, Khamisiyah, and An Nasiriyah Chemical Warfare Related Sites," May 20, 1996.

The earliest possible release date for Al Muthanna has been determined to be on the morning of February 8, 1991. Initial modeling, using the best data then available, showed that this release would not have caused the Czech and French detections. However, a combined DoD and CIA team, the same team that produced the model of the Khamisiyah plume, is again modeling the fallout that could have resulted from the bombing of Al Muthanna. Nevertheless, since the earliest release dates at Al Muthanna are after the date of the Czech and French detections, Al Muthanna can be ruled out as a source for the detections.<sup>58</sup>

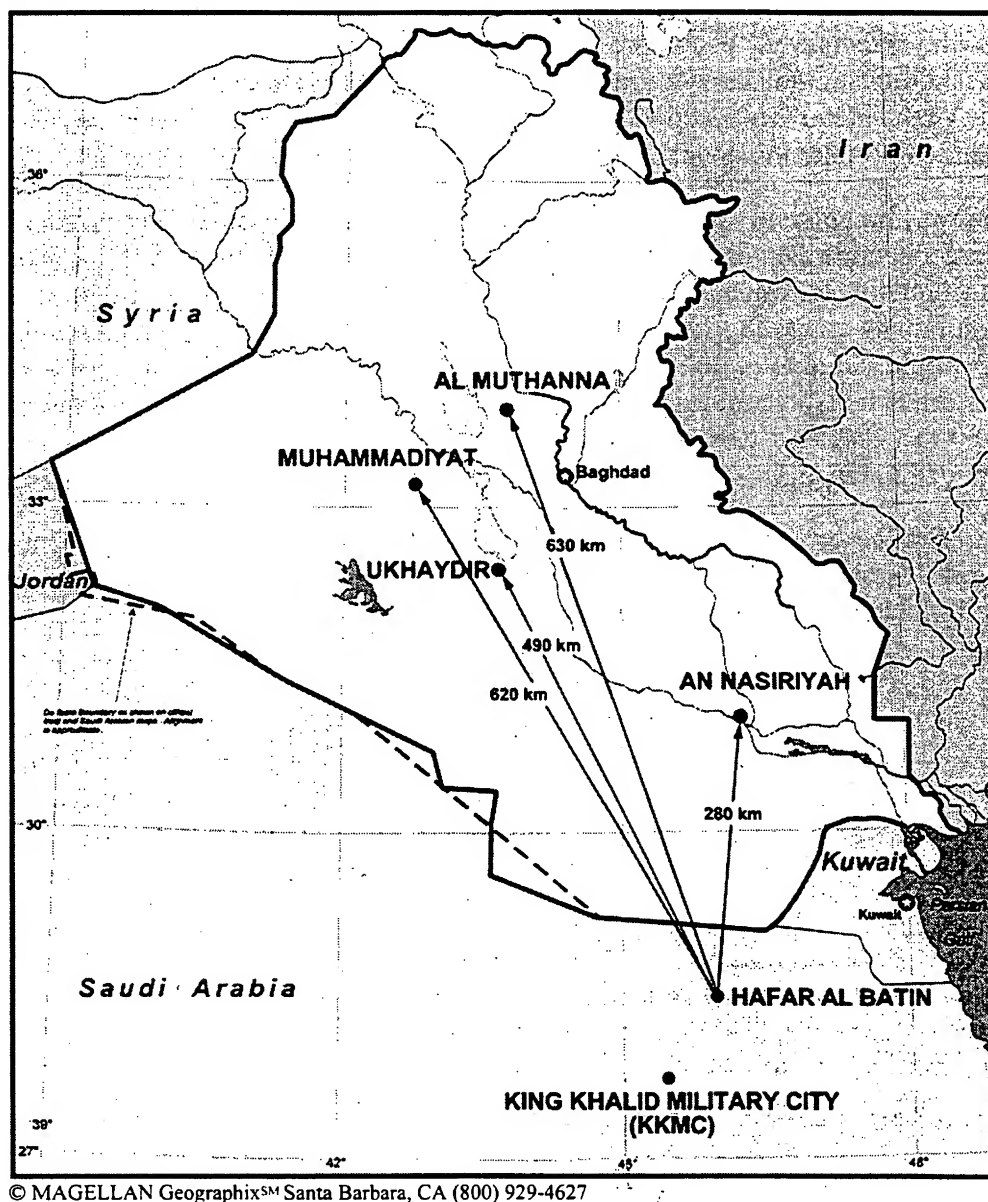


Figure 4. Distances of Chemical Storage Sites from Hafar Al Batin

<sup>58</sup> Memorandum for the Record *Al Muthana Strike Process*. June 2, 1998. CMAT # 1998156-0000014.

The earliest possible date chemical agent could have been released by the bombing of Ukhaydir is January 20, 1991. This date is clearly after the Sarin detections on January 19<sup>th</sup>.<sup>59</sup>

Due to the complexity of the Muhammadiyat storage area, it is difficult to assess when or if Coalition bombing caused a release of agents. The earliest bombing date of the facility occurred January 19, 1991 and continued throughout the war. However, according to a CIA report, the worst case modeling of "all possible bombing dates to find the largest most southerly hazardous area," showed that "downwind dispersions in the general southerly direction for Sarin and Mustard fall below [the general population limit] at about 300 and 130 kilometers, respectively."<sup>60</sup> This is well short of the 620 kilometer distance between Muhammadiyat and the Czechs location at Hafar al Batin.

Although the An Nasiriyah facility, located 280 kilometers from the Czech location in Hafar al Batin, was bombed on January 17<sup>th</sup>, the bunker that contained chemical munitions was not damaged.<sup>61</sup> In May 1996, a United Nations Special Commission (UNSCOM) inspection team spoke with Iraqi representatives, and inspected the bunkers at An Nasiriyah. Iraqi representatives informed UNSCOM officials that approximately 6,000 Mustard-filled munitions were moved from Al Muthanna to An Nasiriyah by January 15, 1991, and stored in bunker number eight. On January 17, 1991, several of the structures at An Nasiriyah were destroyed by aerial bombing, but bunker eight was not hit.<sup>62</sup> At the end of their inspection of the An Nasiriyah facility, UNSCOM inspectors concluded that Coalition bombing did not cause any damage to bunker eight. UNSCOM also concluded that, by the time Coalition occupational forces destroyed bunker eight, the chemical munitions had been removed and only conventional munitions were left in the facility.<sup>63,64</sup>

Another possible cause of the Czech detection was thought to be the presence of interferents, such as insecticides, petroleum products, chemical plant emissions, and pesticides used by the Coalition forces in the area of the Czech detections. However, after a thorough review of the geographic area surrounding the Czech detections, DIA found it unlikely that these interferents caused the Czech detection equipment to alarm. DIA assessed the area as a sparsely populated desert region with no agriculture, no industry, and no likely source of interferents. The only petrochemical facility in the vicinity was a fuel storage area that supplied oil to an adjacent power plant. Analysis of the Czech equipment and procedures used to detect chemical warfare agents supports the

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<sup>59</sup> Central Intelligence Agency, "Update on Potential Mustard Agent Release at Ukhaydir Ammunition Storage Depot." September 4, 1997.

<sup>60</sup> Central Intelligence Agency, "CIA report on Intelligence Related to Gulf War Illnesses," August 2, 1996.

<sup>61</sup> Central Intelligence Agency, "CIA Report on Intelligence Related to Gulf War Illnesses," August 2, 1996.

<sup>62</sup> Department of Defense, "IIR 6 021 0196 96 Iraqi Fallujah, Khamisiyah, and An Nasiriyah Chemical Warfare Related Sites," May 20, 1996.

<sup>63</sup> Department of Defense, "IIR 6 021 0196 96 Iraqi Fallujah, Khamisiyah, and An Nasiriyah Chemical Warfare Related Sites," May 20, 1996.

<sup>64</sup> For more information about this facility can be found in the case narrative titled, *An Nasiriyah Southwest Ammunition Storage Point*.

theory that petroleum products, exhaust gases from heavy equipment, etc., would not interfere with the Czech chemical detection equipment. Finally, DIA examined the possibility that pesticides used by Coalition forces caused the alarms, but this explanation was also found to be unlikely.<sup>65</sup>

Although several possible explanations for the Czech detections have been advanced, both during and subsequent to the Gulf War, the most frequently proposed source for the detections, chemical fallout from Coalition bombing and/or the possible presence for interferents, have been ruled out. Therefore, at this time, without additional information, investigators are unable to determine the source of the chemical agents detected in this incident.

### ***Incident 2 - Czech Mustard Detection January 19, 1991***

On January 19, 1991, the Czechs also reported a detection of Mustard agent in King Khalid Military City (KKMC). (Figure 5) This detection is identified in the Czech logs attached to their Ministry of Defense (MOD) report, and is also recorded in the CENTCOM NBC logs. A Czech Lieutenant Colonel also briefly mentioned this detection to Senator Shelby during his trip to Prague in January 1994. The Lieutenant Colonel told the Senator, "there had been another detection of Mustard in the air near the Engineer School in KKMC, 2-3 days prior to the detection on January 24."<sup>66</sup> Although he did not give a specific date, investigators believe that the Lieutenant Colonel was referring to the CENTCOM log entry of a Mustard detection on January 19<sup>th</sup>, also reported in the Czech Ministry of Defense report.

The Czech Ministry of Defense report states that concentrations of the chemical agent Mustard were detected in the air. The report further states that the "concentrations (reported 0.002 g Yperite [Mustard]/m2 [sic]... without toxic agent specification) represent the limit of maximal admissible (threshold) concentration attacking the human body. Those were very isolated positive results of chemical reconnaissance which were confirmed by none of the other participating states."<sup>67</sup>

The logs attached to the Czech MOD report contain an entry from January 19<sup>th</sup>, 12:10 PM Central European time. The entry states:

Two first line chemical battalions are concentrat[ed] in the rear part of the 20<sup>th</sup> brigade of the KSA's [Kingdom of Saudi Arabia] armed forces.... In the area of our units detected 0.002g/m2 of Yperite. The unit is OK, ready to carry out its tasks.

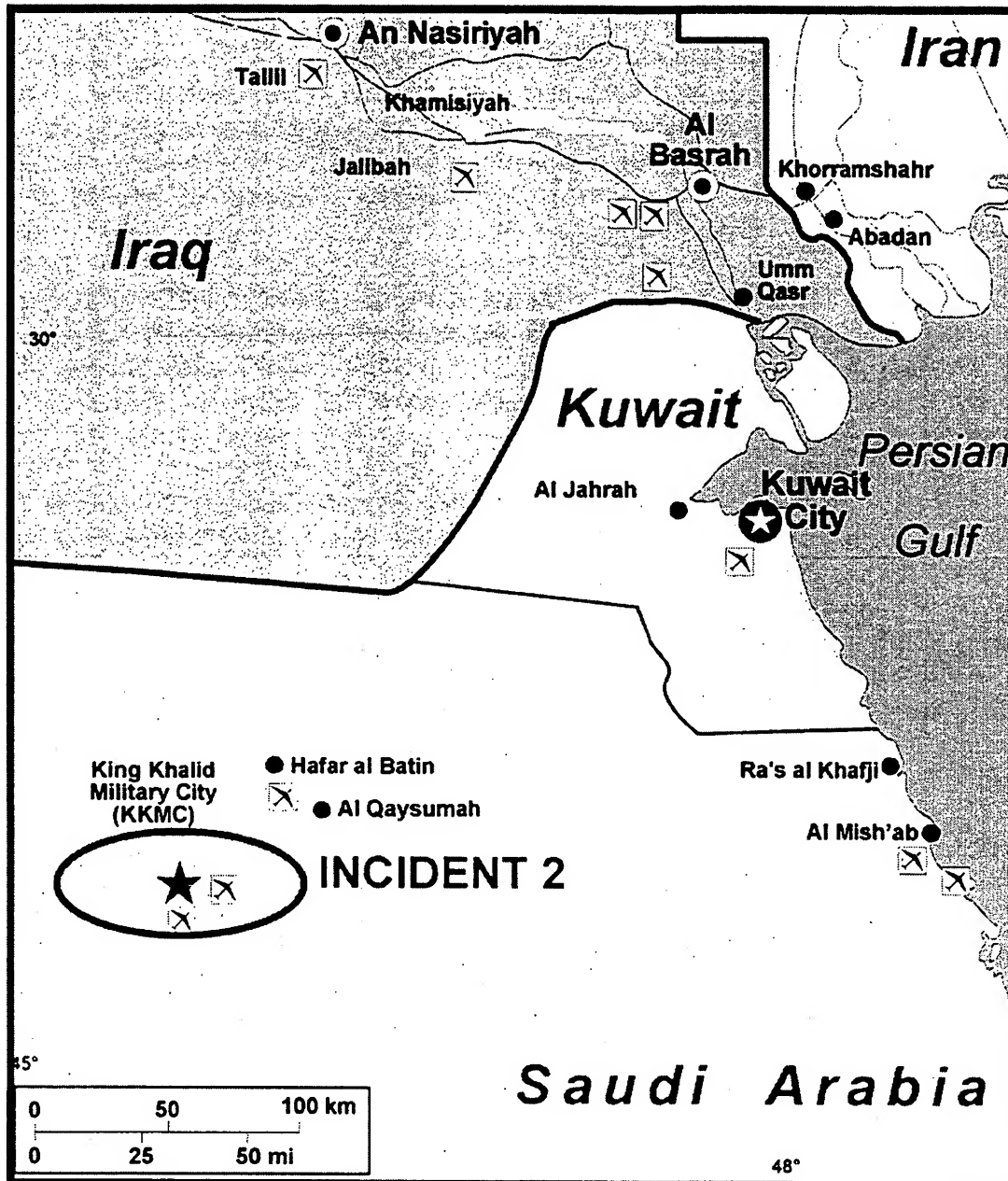
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<sup>65</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>66</sup> Congressional Record, "Senator Shelby's Conclusions on the Persian Gulf Syndrome," Report to the 103<sup>rd</sup> Congress, March 17, 1991, p. S3100.

<sup>67</sup> Czech Ministry of Defense Report, "The Czechoslovak Chemical Defense Unit in the Persian Gulf and Findings of the Investigation Concerning Possible Use of Combat Toxic Agents." September 1997.

Although reports of this detection appear in several places, the only detailed description of the events that surround this detection was found in an article, written by a Czech Major, that was published in a newsletter of a US NBC defense professional society. The Major's account of events was written from notes he made in his personal notebook during the war.<sup>68</sup>



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Figure 5. Kuwaiti Theater of Operations with Incident 2, January 19, 1991

<sup>68</sup> "Czech Detection of CW Agents in the Gulf: A Personal Experience," The ASA Newsletter, Number 97-1, Issue 58, February 7, 1997. "Reprinted with Permission of Applied Sciences and Analysis, Inc."

According to the Major, who was at KKMC when the event took place, the chemical alarm was announced at 10:45 AM. The commander of the squad at KKMC ordered his unit to don chemical protection gear and retreat to a shelter. The Major was assigned with a team to man a stationary chemical monitoring post outside the shelter's entrance. The team used a CHP-71 to monitor for the presence of chemical agents.<sup>69</sup>

Before assuming monitoring duty, the Major's squad received word that the Czech NBC reconnaissance squad had detected both Sarin and Mustard. The time difference between the report of the detection from the reconnaissance squad, located upwind from the shelter, and the shelter team's first detection was approximately 30 minutes.<sup>70</sup> The NBC reconnaissance squad referenced in this incident probably is part of the same units described in Incident 1. However, (as previously described) that reconnaissance squad only reported low levels of Sarin.

Before taking over duty at the monitoring post, the Major took a new CHP-71 and checked its set of detection tubes. His intent was to eliminate "contamination of the inner surface of the entry pipe, [and] contamination of the entry filter in front of the detection tube by acid vapor, smoke and dirt," and because use of old detection tubes could possibly cause false positive readings.<sup>71</sup>

At noon, the Major assumed monitoring duty. At the time, he assessed the weather conditions as "a northwest wind at a speed of 3 meters per second (10.8 kilometers per hour) with an air temperature of 9° Celsius [sic] [48.2° Fahrenheit] with limited visibility." The Major's personal account of the Mustard detection outside the shelter entrance is as follows:

My predecessor briefly informed me that Mustard (Yperite) was present in the air. In accordance with our protocols, I started to operate the CHP-71. In several minutes I saw a color change in the Mustard tube. The yellow color of the tube changed slightly to brown and a reddish brown ring appeared in the upper part of the charge .... [T]his was precisely as the provided standard showed for an Yperite concentration of 0.002 mg/L and higher. It was repeated three more times during one hour .... [I]n accordance with the detectors' handling instructions, I also tested for the group of Sarin, Soman, and V-gases, Cyanogen chloride, hydrogen cyanide, phosgene, and disphosgene. All the results were all negative, except for the Mustard.<sup>72</sup>

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<sup>69</sup> "Czech Detection of CW Agents in the Gulf: A Personal Experience," The ASA Newsletter, Number 97-1, Issue 58, February 7, 1997.

<sup>70</sup> "Czech Detection of CW Agents in the Gulf: A Personal Experience," The ASA Newsletter, Number 97-1, Issue 58, February 7, 1997.

<sup>71</sup> "Czech Detection of CW Agents in the Gulf: A Personal Experience," The ASA Newsletter, Number 97-1, Issue 58, February 7, 1997.

<sup>72</sup> "Czech Detection of CW Agents in the Gulf: A Personal Experience," The ASA Newsletter, Number 97-1, Issue 58, February 7, 1997.



At 1:15 PM the Major was relieved from duty, the observation post continued monitoring for the presence of chemical agents, but yielded negative results. Based on repeated negative results, the chemical alarm was called off at 2:30 PM.<sup>73</sup>

The results of the Major's measurements were reported to the commander of the Czech unit. The article also states that the team collected air samples at the shelter entrance, but tests of the samples performed at the Czech mobile laboratory did not confirm the presence of Mustard agent. The Major postulated why a confirmation from the laboratory was not possible. In his opinion he doubted that the sample of contaminated air contained sufficient amounts of Mustard to produce the chemical reactions needed for the laboratory's equipment. The article also discussed possible sources of the chemical agents detected. According to the Major, one conclusion was that the wind could have possibly picked up the secondary or tertiary aerosol clouds resulting from Coalition bombing of chemical facilities and stockpiles in Iraq.<sup>74</sup>

A team of US ARCENT personnel, stationed forward at KKMC, was involved in follow-up testing after the Czech detections. A Saudi Army officer brought this team to the location of the Czech detection. The team was told that some blister or nerve agent was present around KKMC. Before their arrival at the site, the ARCENT personnel put on their chemical protection gear, but the Saudi Officer did not use any protective measures. The team then broke into two smaller components and conducted several tests in the area of the original Czech detection. Using the M256A1 test kit, they tested for both Mustard and nerve agent. The tests yielded negative results and the unprotected Saudi officer did not show any symptoms of chemical agent poisoning.<sup>75</sup> The negative results of the ARCENT team's tests are inconsistent with the presence of Mustard agent in the area. (Liquid Mustard agent is persistent and would most likely have remained in the area of the Czech detection for several days to weeks.<sup>76</sup>) About an hour after the conclusion of these tests, the US officer who led the team contacted the Czechs to discuss their detection. The only response he received was that the Czechs detected some sort of a blister agent.<sup>77</sup>

The CENTCOM NBC logs contain an entry reporting the Czechs detecting Mustard at KKMC. The entry of Jan 192246 (January 19 at 10:46 PM) reads, "Czech unit reported 2% HD in the air at KKMC at 1100hrs [11:00 AM], rising to 3% HD [Mustard] at 1300."<sup>78,79</sup>

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<sup>73</sup> "Czech Detection of CW Agents in the Gulf: A Personal Experience," The ASA Newsletter, Number 97-1, Issue 58, February 7, 1997.

<sup>74</sup> "Czech Detection of CW Agents in the Gulf: A Personal Experience," The ASA Newsletter, Number 97-1, Issue 58, February 7, 1997.

<sup>75</sup> Interview with ARCENT Chemical Officer, Lead ID 5318, April 4, 1997.

<sup>76</sup> FM 3-100 NBC Operations, Department of the Army, Washington DC, September 17, 1985.

<sup>77</sup> Interview with ARCENT Chemical Officer, Lead ID 5318, April 4, 1997.

<sup>78</sup> CENTCOM Nuclear, Biological and Chemical (NBC) Log entry 192246, January 19, 1991.

<sup>79</sup> The "2% HD rising to 3%HD" could be reference 2 mg/l or .002 mg/m<sup>3</sup>.

The CENTCOM NBC watch officers were functional and area experts. Their job was to monitor NBC events within theater so they could attempt to collect reports of the incidents. The watch officers collected as much information as possible about such events and provided it to the Operations Deputy and the J3, the General in charge of the Operations section of CENTCOM.<sup>80</sup>

There is no record of what CENTCOM did after receiving the Czech report. However, during post-war interviews, both watch officers on duty when the entry was made expressed their skepticism as to the validity of the Czech detections, based on their understanding of the sensitivity of the Czech equipment.

[A]t that time, [we were] not sure of the reliability of the Czech equipment. We were not especially familiar with the technical capabilities of the Czech chemical detection equipment. There was some speculation that it may have been more sensitive than the state of the art US systems at the time, but we did not have any ... specific technical data to do a side by side comparison.<sup>81</sup>

Based on the information provided by the ARCENT team at KKMC and their understanding of the Czech's detection capabilities, at the time of the detections the CENTCOM NBC watch officers determined that the Czech detections were not accurate. This assessment was based on a number of factors: 1. the absence of reports by other units that could have corroborated the presence of any sort of chemical agent within the atmosphere; 2. the distances between the known sites in Iraq that were bombed by Coalition forces and the area of the detection; and, 3. their assessment was based on their attempt to determine why the Czechs would provide reports that were a percentage of something in the air when detectors do not usually have the ability to give percentages.<sup>82</sup> This incident did not receive more attention from the watch officers because they felt there was no cause for concern. The Czechs underscored and highlighted the fact that the detection was below a safety threshold level.<sup>83</sup>

### *Analysis of Incident 2*

The Czech team at the monitoring post used the CHP-71 for their initial detection, as well as for the confirmation tests. The sample of air the squad took for further testing at their mobile laboratory did not confirm the presence of Mustard agent when tested in the Czech mobile laboratory. Furthermore, other units in the vicinity of KKMC did not report similar chemical alarms. Subsequent tests by US ARCENT personnel also failed

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<sup>80</sup> CENTCOM NBC Log Investigation, Interview with CENTCOM NBC Watch Officer. January 27, 1997. CMAT #1998027-0000004.

<sup>81</sup> CENTCOM NBC Log Investigation, Interview with CENTCOM NBC Watch Officer. January 28, 1997. CMAT #1998027-0000004.

<sup>82</sup> CENTCOM NBC Log Investigation, Interview with CENTCOM NBC Watch Officer. January 27, 1997. CMAT #1998027-0000004.

<sup>83</sup> CENTCOM NBC Log Investigation, Interview with CENTCOM NBC Watch Officer. January 27, 1997. CMAT #1998027-0000004.

to confirm the presence of Mustard. Therefore, there was no confirmation of the detection using a different biochemical technique.

Although a Czech Lieutenant Colonel commented to Senator Shelby about hearing of another detection at about the same time, no further comments or details were provided to the Senator or other DoD representatives who have visited Prague inquiring about detections during the Gulf War. Furthermore, as with the January 19<sup>th</sup> Sarin detection (Incident 1), fallout from the bombing of the Iraqi chemical sites (Al Muthanna, Muhammadiyat and Ukhaydir) occurred after January 19<sup>th</sup> and, therefore, could not be a possible source of the Mustard agent for this detection. As noted above, it has also been determined that damage incurred at An Nasiriyah on January 17<sup>th</sup>, did not affect any bunkers containing chemical munitions. Thus, it is unlikely that a chemical release occurred.

### ***Incidents 3, 4 and 5 - French Detections January 19-21, 1991***

Incidents 3, 4, and 5 (Figure 6) are related by the paucity of information on any one of them, by the proximity of the locations of their occurrences, and by the lack of acknowledgement of these events by either the Czech or French governments. They are, in all likelihood, separate reports of the same possible detection, as recorded and forwarded by different units.

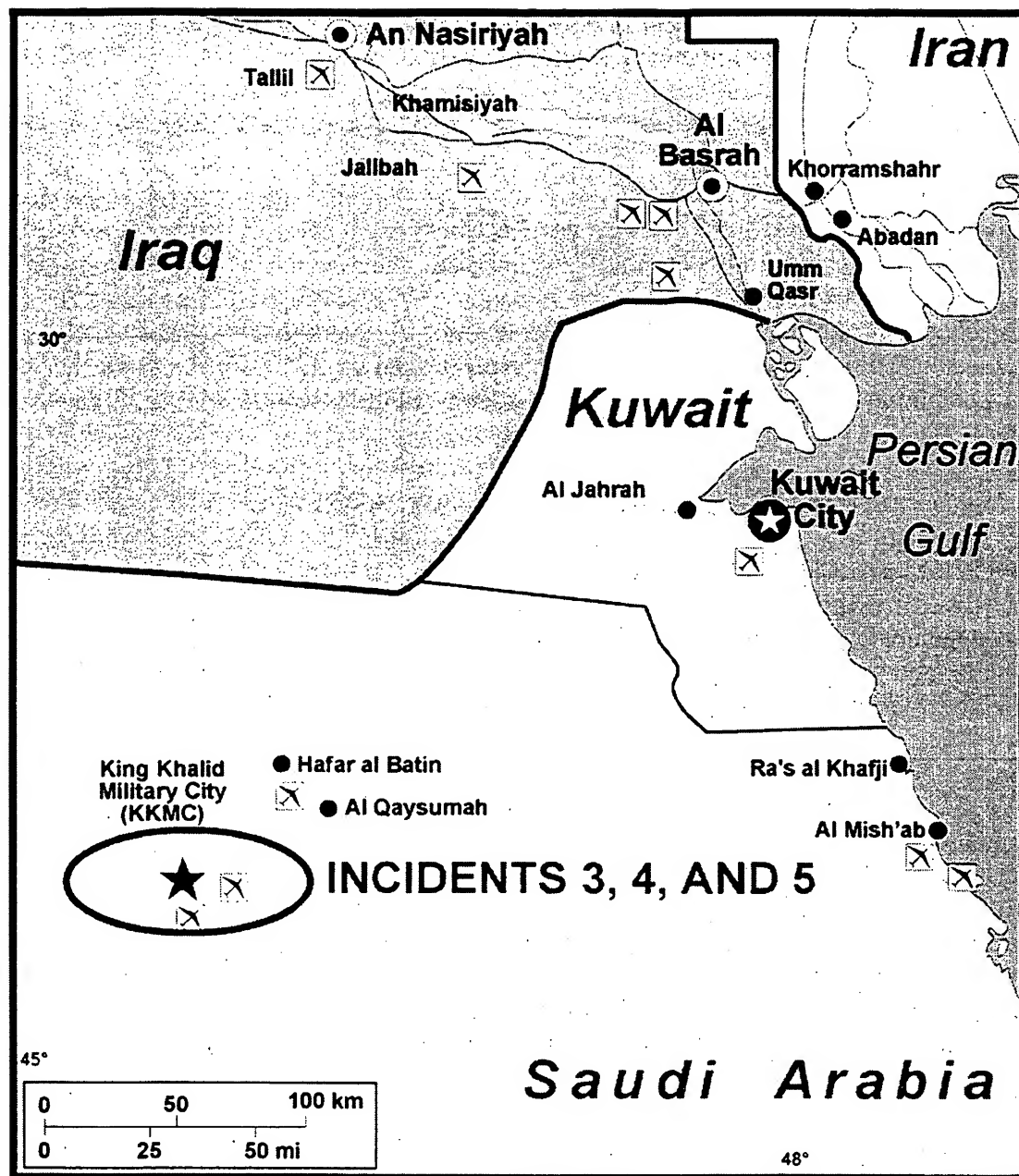
Incident 3: On January 19, 1991, a French unit approximately 30 kilometers from KKMCM had a monitoring device indicate a presence of chemical agents. (Incident 3) Saudi authorities requested that the Czech chemical unit conduct a reconnaissance of the area. The Czechs indicated that they confirmed the presence of the nerve agent Tabun or Sarin. Tests conducted in the mobile lab determined that the concentrations were very low. According to the Defense Science Board report, the Czechs also indicated that the contaminated area was very small, approximately three square meters.<sup>84</sup> This report of a chemical detection is only mentioned in a timeline in the Defense Science Board report. It is not discussed in the body of the report nor is it mentioned in the CENTCOM NBC logs.

An XVIII Airborne Corps Log, however, contains an entry for January 19<sup>th</sup> at 1910 hrs (7:10 PM) that reports the "French 6 battalion reported "gas/gas/gas" on 18 Corps net." This log entry also contains a notation that, "vapor had set alarm, believe to be from CW plant that was destroyed."<sup>85</sup> This matches almost exactly the words in the Defense Science Board Chem/Bio timeline, except the detection is listed as occurring on January 20, 1991.

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<sup>84</sup> Lederberg, Joshua, "Report of the Defense Science Board Task Force on Persian Gulf War Health Effects," June 1994, Appendix B.

<sup>85</sup> XVIII Airborne Corps Daily Staff Journal. 1910, January 19, 1991.



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Figure 6. Kuwaiti Theater of Operations with Incidents 3-5, January 19-21, 1991

Incident 4: The CENTCOM NBC log dated 201710 Jan 91 (January 20<sup>th</sup> at 5:10pm) states:

... from ARCENT ... Czech recon, DS [direct support] to French report detect GA[Tabun]/GB[Sarin] and that hazard is flowing down from factory/storage bombed in Iraq. Predictably, this has become/is going to become a problem.

The last sentence refers to the watch officers' opinions. The watch officers were expressing their frustration over how the Czechs chose to report the detections, rather than a concern of down wind hazards caused from Coalition bombings of Iraqi chemical facilities.<sup>86,87,88</sup>

In response to the report, the CENTCOM NBC watch officer requested that US Special Forces look into the matter.<sup>89</sup> However, another log entry for 210520 Jan 91 (January 21 at 0520 or 5:20 AM) reports that Special Forces personnel did not detect any chemical agents in the vicinity of KKMC.<sup>90</sup>

An Intelligence Spot Report from January 22, 1991, reported that the French Chemical NCO reported at 8:25 AM on January 21, 1991, the "French chemical alarms activated in the French TAA. The French report finding GA [Tabun], GB [Sarin] and H blister in 'sublethal quantities'." In the same report, the French assessed this incident to be a result of the "bombing of chemical agent storage in As Salman"<sup>91</sup>.

As Salman, also known as Salman Pak, was primarily a biological weapons research facility that conducted some research on chemical agents. In the late 1970's and early 1980's, CS was produced at As Salman, but in the early 1980's all military scale production of CS and other agents was moved to Al Muthanna. After the Gulf War, Iraq declared to UNSCOM that the As Salman facility was dismantled prior to the start of the Air Campaign to protect equipment from being destroyed during coalition bombing.<sup>92</sup> Due to the Iraqi declarations and the results of UNSCOM inspections, it is safe to say that the chemical agents the French reported did not come from the bombing of As Salman.

Incident 5: Another CENTCOM Log entry contains a report of a French detection on January 21<sup>st</sup> at 3:40 PM. This entry reported a detection near an ammunition storage facility at KKMC and due to the frequent SCUD activity, people were getting nervous. The Czechs were called in to confirm the detection and they detected "trace quantities of 'Tabun, Soman, Yperite' [Mustard]." Again, fallout from Coalition bombing of Iraqi chemical facilities was theorized to be the source of the detection.<sup>93</sup> It is important to point out that the Iraqis had no known stores of Soman during the Gulf War.<sup>94</sup> The Defense Science Board timeline contains a similar entry, as does a 101<sup>st</sup> Airborne journal

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<sup>86</sup> CENTCOM NBC Log Investigation, Interview with CENTCOM NBC Watch Officer. January 27, 1997. CMAT #1998027-0000004.

<sup>87</sup> CENTCOM NBC Log Investigation, Interview with CENTCOM NBC Watch Officer. January 21, 1997. CMAT #1998027-0000004.

<sup>88</sup> The CENTCOM NBC Watch Officer's frustration was explained in Incident 2.

<sup>89</sup> CENTCOM Nuclear, Biological and Chemical (NBC) Log entry 201710, January 20, 1991.

<sup>90</sup> CENTCOM Nuclear, Biological and Chemical (NBC) Log entry 210520, January 21, 1991.

<sup>91</sup> Intelligence Spot Report January 22, 1991. CMAT# 1996299-012-0000004.

<sup>92</sup> The United Nations, *Blue Book Series, Volume IX: The United Nations and the Iraq-Kuwait Conflict 1990-1996*, New York, NY: Department of Public Information, United Nations, 1996, pp. 732-736.

<sup>93</sup> CENTCOM Nuclear, Biological and Chemical (NBC) Log entry 211540, January 21, 1991.

<sup>94</sup> The United Nations, *Blue Book Series, Volume IX: The United Nations and the Iraq-Kuwait Conflict 1990-1996*, New York, NY: Department of Public Information, United Nations, 1996, pp. 656-657.

which reports that a test by Czechs in the vicinity of KKMC confirmed the presence of Tabun, Sarin, and blister agents in sublethal quantities. Again, speculation as to the source of these chemicals pointed toward release from bombed chemical weapon facilities and bunkers.<sup>95</sup> Another notation in the Defense Science Board timeline states, "French at KKMC detect low level chemical agent. US chemical tests negative."<sup>96</sup>

#### *Analysis of Incidents 3, 4 and 5*

Investigators believe that the incidents described above are different reports of a single incident. All three incidents reported a possible presence of a combination of Sarin, Soman, Tabun, or blister agents. Also, in the reports of the three incidents the Czechs were reported to be working either in direct support of the French or they were called in to confirm the French reports. Therefore, investigators believe that it is quite possible that multiple organizations reported the same detection to CENTCOM and subordinate elements to CENTCOM at different times. The difference in reporting dates could be accounted for by considering the time involved in relaying the information through each organization's own channels and through the various Coalition forces involved before passing the information to CENTCOM.

The only information available about these detections is contained in the various logs. An analysis of the incidents by the Defense Intelligence Agency reports that the Czechs did not file a situation report on their participation in these events of January 20-21,<sup>97</sup> nor was their involvement in these events included in the Ministry of Defense's report. Therefore, little information is available to clarify the specific events surrounding these log entries. The descriptions of the incidents do not provide detail about the detection techniques and process used, therefore, it is unknown how or if a confirmation took place. Neither the French nor the Czechs reported these possible detections to Senator Shelby's delegation during his fact finding mission. Furthermore, the detections took place in the vicinity of KKMC where troops from other Coalition countries were stationed and no other troops reported detecting chemical agents.

Although it is impossible to know on exactly what date these incidents occurred, the timing roughly corresponds with that of Incident 1. If they occurred on January 19<sup>th</sup>, as reported in the Defense Science Board timeline, Coalition bombing of Iraqi chemical facilities cannot account for these reported detections of chemical agents in the vicinity of KKMC, because the known possible releases occurred after January 19<sup>th</sup>.

As mentioned previously, the Coalition bombing on January 20, 1991, may have resulted in a release of Mustard agent from Ukaydir. Initial modeling of the plume of Mustard

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<sup>95</sup> 101<sup>st</sup> Airborne Division (Air Assault) Command Tactical Operations Center Journal Sheet, 210825 and 211050.

<sup>96</sup> Lederberg, Joshua, "Report of the Defense Science Board Task Force on Persian Gulf War Health Effects," June 1994, Appendix B.

<sup>97</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

agent that may have resulted from this release is projected to have extended 40 kilometers from the facility. However, the Ukaydir facility is over 200 kilometers from the Saudi border, so the release of agents on the 20<sup>th</sup> would not have resulted in the detections if they occurred on January 20 or 21.<sup>98</sup>

#### *Incident 6 - Czech Detection of Mustard January 24, 1991*

On January 24, 1991, a Saudi liaison officer summoned a Czech chemical unit in KKMC to investigate a patch of discolored sand in a remote area of the desert several kilometers away from KKMC.<sup>99,100</sup> (Figure 7) Under the direction of the liaison officer, the Czech specialists were led to a small area of what appeared to be wet desert soil.<sup>101</sup> The patch of sand measured approximately 60 centimeters by 200 centimeters.<sup>102</sup>

The Czechs tested the content of the wet sand and determined that it contained Mustard agent. They then confirmed the detection with the PCHL-90 portable laboratory which used a complex chemical test series based on benzoic acid, phenol and other aromatic chemicals. The test confirmed the initial detection of Mustard agent.<sup>103</sup> Since the two different testing protocols used by the Czech indicated a positive presence of Mustard agent, the Czechs did not take a sand sample for additional testing at the mobile laboratory. Due to the extremely limited nature of the contamination, the remoteness of the site and the absence of any Coalition personnel stationed anywhere in the immediate location, the site was left without any markings.<sup>104</sup>

The Czechs filed a situation report with the Saudi forces, but the CENTCOM NBC logs do not contain a record of this detection. Also, this investigation has found no record of this incident ever being reported to CENTCOM. Furthermore, investigators have determined that no other units were contacted to independently confirm the presence of Mustard agent in the sand.

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<sup>98</sup> CIA Persian Gulf War Illnesses Task Force, "Update on Potential Mustard Agent Release at Ukaydir Ammunition Storage Depot", September 4, 1997.

<sup>99</sup> Congressional Record, "Senator Shelby's Conclusions on the Persian Gulf Syndrome," Report to the 103<sup>rd</sup> Congress, March 17, 1991, p. S3100.

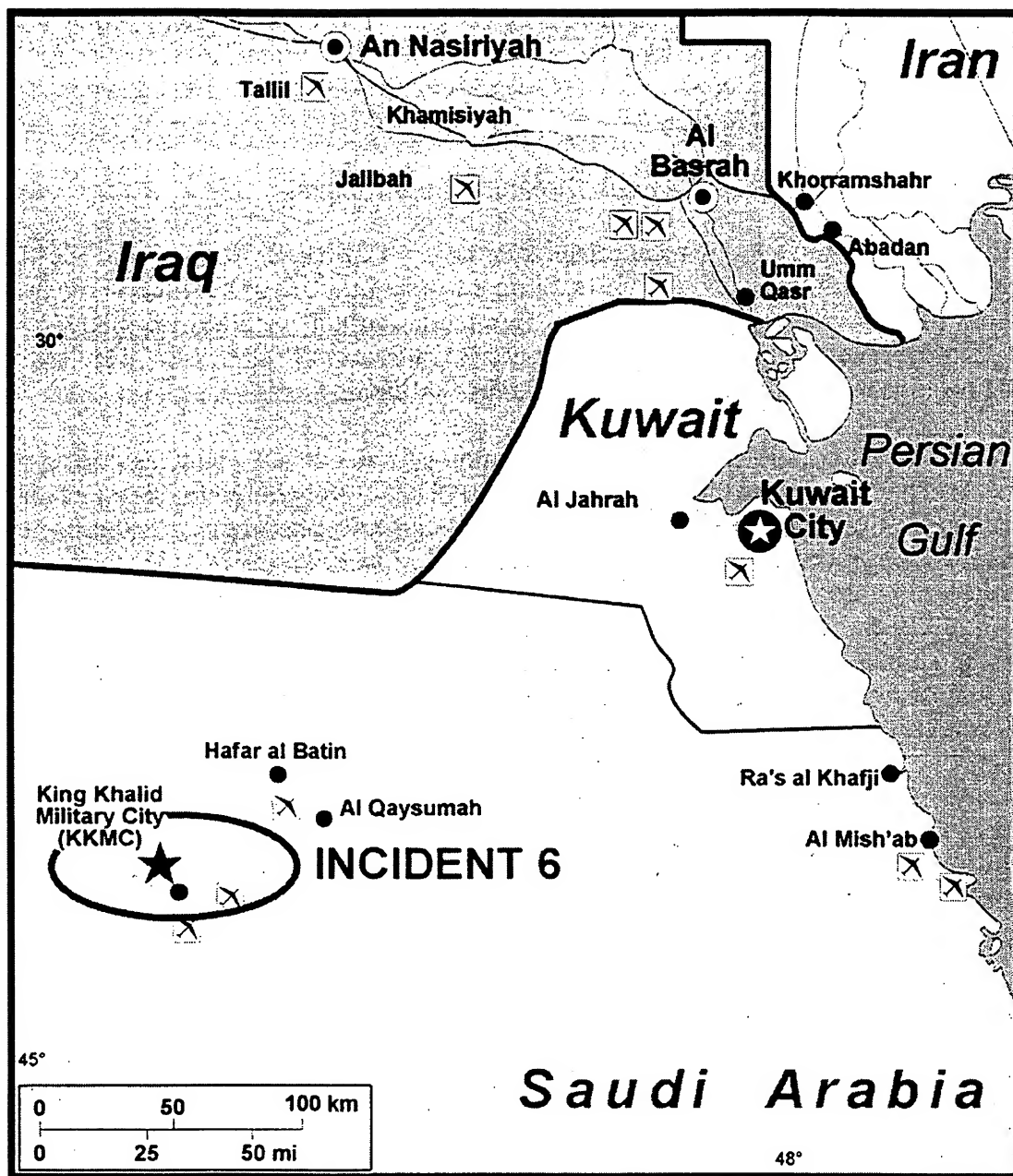
<sup>100</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>101</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>102</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>103</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>104</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.



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GW-0015

Figure 7. Kuwaiti Theater of Operations with Incident 6, January 24, 1991

### *Analysis of Incident 6*

The Czech Republic has acknowledged this incident, but they have provided few clues as to the potential source of the Mustard agent. The Czech officers at the scene of the detection stated that there were no munitions fragments, craters, or other indicators of military involvement at the site. There were also no SCUD missile alerts for this area prior to the testing of the wet patch of sand. The presence of a liquid agent, in the form of the wet patch of sand, precludes the possibility of downwind vapor contamination



from the bombing of chemical facilities inside Iraq.<sup>105</sup> Additionally, the Czechs and the Saudis have both denied having any live chemical agents or simulants in the theater.<sup>106,107</sup> Without additional information, it is impossible to determine a probable source for this isolated area of liquid Mustard contamination.

This incident has been characterized as valid by the DoD and credible in PAC testimony on May 1, 1996,<sup>108</sup> by members of the PGIIT and CIA. This characterization was based on the capabilities of the Czech equipment and the known processes used by the Czech personnel. However, no samples of the liquid that was detected were collected for further testing.

#### ***Incident 7 - French Detection of Nerve Agent January 24 or 25, 1991***

The French reported to the Shelby delegation that on the evening of January 24 or 25, 1991, French alarms indicated the presence of nerve and blister agents at a logistics facility approximately 27 kilometers south of KKMC. (Figure 8) The French chemical alarms were activated at two locations about 100 meters apart. A French Colonel who arrived at the location about 30 minutes after the initial alarms indicated that the litmus badges on the French protective suits registered the presence of Mustard agent.<sup>109</sup> The French then contacted a Czech chemical unit and asked them to conduct tests to verify the presence of chemical agents. The Czech unit arrived about two hours later, and confirmed the presence of very low levels of nerve and Mustard agent.<sup>110</sup> It is not known whether this incident was reported to CENTCOM because the pages containing these dates are missing from the logs recovered after the war.<sup>111</sup>

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<sup>105</sup> Defense Intelligence Agency, Report to the Defense Science Board, "Intelligence Assessment of the Chemical and Biological Warfare in the Gulf," September 25, 1995.

<sup>106</sup> Congressional Record, "Senator Shelby's Conclusions on the Persian Gulf Syndrome," Report to the 103<sup>rd</sup> Congress, March 17, 1991, p. S3100.

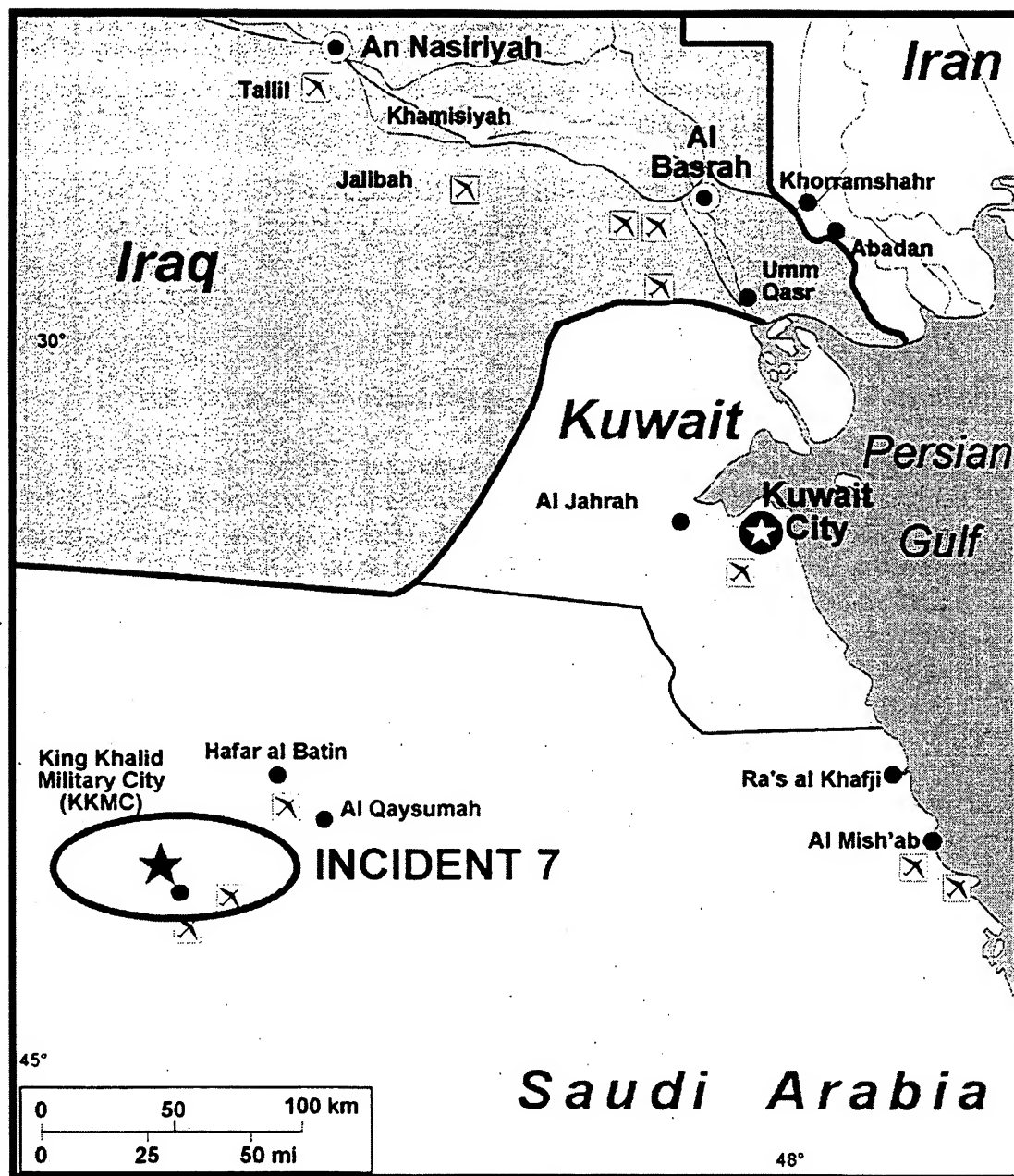
<sup>107</sup> Defense Intelligence Agency, IIR 6 884 0068 94 "Chemical Weapons in Saudi Arabia." January 9, 1994.

<sup>108</sup> Testimony of LTC Jimmy E. Martin, PGIIT, and Ms. Sylvia L. Copeland, CIA, before the Presidential Advisory Committee, May 1, 1996.

<sup>109</sup> Congressional Record, "Senator Shelby's Conclusions on the Persian Gulf Syndrome," Report to the 103<sup>rd</sup> Congress, March 17, 1991, p. S3100.

<sup>110</sup> Congressional Record, "Senator Shelby's Conclusions on the Persian Gulf Syndrome," Report to the 103<sup>rd</sup> Congress, March 17, 1991, p. S3100.

<sup>111</sup> The CENTCOM log investigation was formally handed over to the Department of Defense Inspector General on March 3, 1997. A copy of the Inspector General's findings is located on GulfLINK.



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GW-0016

Figure 8. Kuwaiti Theater of Operations with Incident 7, January 24-25, 1991

#### *Analysis of Incident 7*

To date, this is the only information currently available about this detection. The government of France has not disclosed information pertaining to their detection equipment or training methodologies. The French have also not provided any additional or more detailed information about this incident. Without additional information, it is impossible to determine potential sources for the nerve and blister agents detected.

## ASSESSMENT

Due to the lack of confirming evidence, it is difficult to assess the reports of low-level chemical agent detection by Czech and French forces between January 19 and 24, 1991. Consequently, the assessments of the incidents described in this report will remain interim until more substantial evidence is forthcoming. It is well documented that the Czech and French detectors alarmed, but many unknowns still remain, and there is little evidence of independent confirmation of the possible detections. This investigation has found no evidence of missile or artillery attacks, and no reported enemy activity at the time of the Czech and French reports. Further, the Czechs and the French have found no evidence of injuries resulting from chemical exposure in the areas of the reported detections.

Of their four possible chemical detections, the government of the Czech Republic recognizes only two, the January 19<sup>th</sup> report of possible nerve agent vapor that occurred near Hafar al Batin (Incident 1) and the report of the discolored sand near KKMC on January 24 (Incident 6). Although the United States cannot independently verify the Czech reports, the DoD is confident in the Czech's ability to detect the presence of chemical agents. This confidence is based on in-depth analysis by US technical experts of the Czech's technical competence and the reliability of the Czech equipment.

The government of France has never acknowledged any of their reported detections, and despite repeated requests of the French government, this investigation received no information about their detections. Consequently, their chemical detection capability and the technical accuracy of the detections cannot be assessed, and the information about the detections is incomplete.

Starting in late 1993, the US intelligence community, and the Department of Defense began to investigate the possible sources of the Czech and French reports. Efforts to determine possible sources included talks with Coalition nations, including the Czechs and French, examination of Czech equipment, research in DoD records, and computer modeling of hundreds of possible scenarios.

Despite an exhaustive examination, a distinct source of the chemical agents could not be determined. During the war, fallout from Coalition bombing of Iraqi chemical facilities was repeatedly speculated to be the cause of the possible detections. One proposed fallout theory postulated that winds aloft carried the chemicals to the locations where the detections took place. However, this analysis was based upon the releases occurring during the early morning hours on the dates of the detections and investigators have no evidence that this occurred. Investigators have been unable to identify a large release of agent from Coalition bombings of the An Nasiriyah, Al Muthanna, Ukhaydir, or Muhammadiyat facilities occurring prior to the Czech detections on January 19, 1991. United Nations Special Commission (UNSCOM) inspectors have concluded that no chemical munitions were destroyed at An Nasiriyah during the January 17<sup>th</sup> bombing; therefore, it was eliminated as a possible source for the detections. Furthermore, the earliest possible release date for Al Muthanna has been determined to be February 8,

1991. On January 20, 1991, Coalition bombing of the Ukhaydir facility may have caused a release of Mustard agent. The resulting Mustard plume is projected to have extended only 40 kilometers from the facility. Ukhaydir is several hundred kilometers from the Saudi border. Therefore, this release could not be the cause of any of the reported detections. Due to the complexity of the Muhammadiyat facility, research is continuing to determine when or if chemical munitions were destroyed there. Consequently, it is unclear at this time whether any chemical plume, even one below the general population limit (i.e., at a level the US government considers safe and non-threatening) reached the locations of the Czech and French detections in Hafar Al Batin and KKMCC. Although the CIA's preliminary work, based on the early modeling of the possible release of agents from all four sites, concluded that they were not the source of Czech or French detections, investigators are reassessing each incident using more sophisticated techniques. The results will be published in separate case narratives.

As mentioned earlier, the Czech reports on January 19<sup>th</sup> (Incident 1) and on January 24<sup>th</sup> (Incident 6) were assessed as valid by the DoD in 1993, and credible by the CIA in 1996. These assessments were based on the capabilities of the Czech equipment and the known processes used by the Czech personnel. However, capable equipment and known analyses processes are insufficient to substantiate the presence of chemical warfare agents. To develop an assessment, a methodology must be followed that requires evidence of what was detected and under what circumstances it was detected—i.e., some independent confirmation. Although this investigation has not been able to uncover such independent confirmation, the evidence that has been found does not change the original assessments.

For the remaining Czech incident and the combined Czech and French incidents, investigators have found no evidence that confirms any detection, obtained no details about them from either the French or the Czechs, and have been unable to postulate reasonable or logical potential sources for the chemical agents reported. Consequently, due to the overall lack of information this investigation's assessment for Incidents 2, 3, 4, 5 and 7 as "Indeterminate." Without additional details, such as a potential source for the contamination, a more definitive assessment cannot be made.

## **Lessons Learned**

Investigators from the Investigations and Analysis Directorate have identified several key lessons learned while investigating the Czech and French reports of possible chemical agent detections. The following lessons learned do not represent opinions or positions of other departments or agencies outside the US Department of Defense, nor do they represent the lessons learned by Coalition nations identified in this case narrative.

### **Communication**

One of the most important lessons is in the area of communication. Members of the Coalition reported to CENTCOM in different manners. As a result, the Czechs reported to the Saudis and the Saudis, in turn, reported to CENTCOM. This delayed

CENTCOM's effort to confirm the detection and any other actions required as a result of the report. If a more direct channel of communication had been established, CENTCOM would have had more detailed and timely accounts of the detections.

### **Coalition Detection Capabilities**

Another lesson learned is the importance of being familiar with the chemical detection equipment used by Coalition members, its strengths, its weaknesses, and the abilities of the NBC specialists trained to use it. Whether or not the CENTCOM NBC staff understood the sensitivity of the Czech equipment, and whether that knowledge would have changed what they did at the time is unclear, but, in general, a complete understanding of this equipment would have given the CENTCOM specialists working NBC issues a better understanding of reported readings, and made them better able to judge the proper actions to take in response to a reported detection.

### **Confirmation**

Another lesson learned is the need for an established, well-understood confirmation process. At times, confirmatory tests were attempted several hours after the initial detection was reported. This delay was due, in part, to the lack of an established system for conducting the confirmatory tests. There was also a lack of understanding or agreement on the part of decision-makers as to what constituted confirmation of a detection. If a confirmation system had been established, verification could have been conducted in a more timely and thorough manner, thus giving more accurate results. Also, log entries should have more accurately recorded whether the reports had been properly confirmed or merely suspected. Another requirement of the confirmatory process is the need for adequate air and/or soil samples for external confirmation of a reported "valid" detection. These samples would allow other Coalition nations to test for the presence of agents and complete the confirmatory process.

### **Low Level Chemical Agents**

The consequences of low level chemical agent exposure needs to be better understood by the individuals making decisions about reported detections. In part, this is related to the lessons learned above (e.g., the Czech detectors detected lower concentrations of agent than would have US detectors, so confirmation with a US detector might not have been a logical decision). Also, commanders cannot make informed decisions about actions that affect their troops without the knowledge of the possible presence and effects of low levels of agents. This could only further help protect US service members in future conflicts.

*This case is still being investigated. Due to difficulty in obtaining detailed evidence from the Czech and French governments, we would especially like to hear from anyone with personal knowledge of these incidents, i.e., people who were present at the time or who processed any of the reports that were generated as a result of these detections. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DoD Persian Gulf Task Force Hot Line at 1-800-472-6719.*

## ***TAB A - ACRONYMS AND GLOSSARY***

This provides a listing of acronyms found in this report. Additionally, the glossary section provides definitions for selected technical terms that are not found in common usage.

### **Acronyms**

ARCENT.....	Army Central Command
CENTCOM.....	United States Central Command
CIA.....	Central Intelligence Agency
CRUR.....	US Armed Services Center for Research of Unit Records
CSFR.....	Czech and Slovak Federal Republic
CW.....	Chemical Warfare
DIA.....	Defense Intelligence Agency
DoD.....	Department of Defense
DSB.....	Defense Science Board
FAR.....	Force d'Action Rapide
FM.....	Field Manual
FBIS.....	Foreign Broadcast Information Service
GA.....	Tabun (Nerve Agent)
GB.....	Sarin (Nerve Agent)
GD.....	Soman (Nerve Agent)
GF.....	Cyclosarin (Nerve Agent)
H.....	Mustard (Blister Agent)
HD.....	Distilled Mustard (Blister Agent)
HE.....	High Explosives
HHC.....	Headquarters and Headquarters Company
HQ.....	Headquarters
KKMC.....	King Khalid Military City
KSA.....	Kingdom of Saudi Arabia
MOD.....	Ministry of Defense
NBC.....	Nuclear, Biological, and Chemical
PGIIT.....	Persian Gulf Illnesses Investigation Team
TAC CP.....	Tactical Command Post
TOC.....	Tactical Operations Center
UIC.....	Unit Identification Code
UNSCOM.....	United Nations Special Commission

## Glossary

### Blister Agents<sup>112</sup>

Mustard (H) agent was used during the later parts of World War I. In its pure state, Mustard is colorless and almost odorless. The name Mustard comes from earlier methods of production that yielded an impure, Mustard smelling product. Mustard is also claimed to have a smell similar to rotten onions.

Distilled Mustard (HD) was originally produced from H by a purification process of washing and vacuum distillation. HD is a colorless to amber colored liquid with a garlic-like odor. It has less odor and a slightly greater blistering power than H and is more stable in storage. It is used as an agent to produce casualties after a certain delay, the duration of which depends upon the munitions used, the weather and the exposure concentration. HD is heavier than water, but small droplets will float on the water surface and present a hazard.

Heavily splashed liquid Mustard persists one to two days or more in concentrations that produce casualties for military significance under average weather conditions and for a week to months under very cold conditions. HD on soil can cause blistering for about two weeks. The persistency in running water is only a few days, while the persistency in stagnant water can be several months. HD is about twice as persistent in sea water.

Mustard acts first as a cell irritant and finally as a cell poison on all tissue surfaces contacted. Early symptoms include inflammation of the eyes; inflammation of the nose, throat, trachea, bronchi, and lung tissue; and redness of the skin. Blistering or ulceration are also likely to occur. Other effects may include vomiting and fever that begin around the same time as the skin starts to redden.

Eyes are very sensitive to Mustard in low concentrations, but skin damage requires a much larger concentration. HD causes casualties at lower concentrations in hot and humid weather, because the body is moist with perspiration and wet skin absorbs more Mustard than does dry skin. HD has a very low detoxification rate; therefore, repeated exposures are cumulative in the body. Furthermore, individuals can be sensitized to Mustard.

Individuals can be protected from small Mustard droplets or vapor by wearing protective masks and permeable protective clothing.

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<sup>112</sup> Headquarters, Department of the Army, Navy and Air Force, FM 3-9, *Potential Military Chemical/Biological Agents and Compounds*, Washington, DC, December 1990.

The use of impermeable clothing and masks can protect against large droplets, splashes, and smears.

### Nerve Agents<sup>113</sup>

Tabun (GA) is a brownish to colorless liquid agent that gives off a colorless vapor and causes casualties quickly. It was first developed by the Germans before the start of World War II. GA enters the body primarily through the respiratory tract, but it is also highly toxic through the skin and digestive tract. It is approximately 20 times more persistent than Sarin (GB) but not as stable in storage. GA has a high toxicity to the eyes, and a very low concentration of the vapors causes the pupil to constrict. This results in an individual having difficulty seeing in dim light. GA liquid penetrates the skin quickly; therefore decontamination of the smallest drop of the liquid agent is essential.

The normal sequence of symptoms for vapor exposure is: running nose, tightness of chest, dimness of vision and pin-pointing of the eye pupils, difficulty breathing, drooling and excessive sweating, nausea, vomiting, cramps, involuntary defecation and urination, twitching, jerking and staggering, headache, drowsiness, coma and confusion. These symptoms are followed by cessation of breathing and death. These symptoms appear much more slowly from skin dosage than from respiratory dosage. Respiratory lethal dosages kill in 1 to 10 minutes; liquid in the eye kills nearly as fast; death may occur through skin absorption in one to two minutes; or death may also be delayed for one or two hours.

A protective mask and protective clothing provide protection from all nerve agents. Protective clothing gives off G agents for about 30 minutes after contact with vapor. All liquid agent should immediately be removed from protective clothing.

The persistency of GA depends upon the munitions used and the weather. Heavily splashed liquid persists one to two days under average weather conditions. It can persist about one day at 20°C and about six days at 5°C.

Sarin gas (GB) was developed by the Germans after they developed GA. The symptoms exhibited by and protection methods used for GB are identical to GA. Death usually occurs within 15 minutes after a fatal dosage is absorbed.

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<sup>113</sup> Headquarters, Department of the Army, Navy and Air Force, FM 3-9, *Potential Military Chemical/Biological Agents and Compounds*, Washington, DC, December 1990.



Soman (GD) is a colorless liquid that gives off a colorless vapor. Skin and eye toxicity is three times that of GA. Lethal respiratory and eye dosages usually kill in 1 to 10 minutes, while dosages absorbed through the skin can take up to one to two hours. The symptoms exhibited by and protection methods used for GD are identical to GA and GB.

#### **V Agents<sup>114</sup>**

V agents are generally colorless and odorless liquids which do not evaporate rapidly. The standard V agent is VX while others include VE, VG, and VS.

VX (the US standard V agent) is very persistent, odorless, amber colored liquid similar in appearance to motor oil. VX is much more persistent than G agents and causes death by the same mechanisms as G nerve agents. Since VX has a low volatility, liquid droplets on the skin do not evaporate quickly which increases its absorption. VX absorption through the skin is estimated to be more than 1000 times as toxic as GB and by inhalation is estimated to be 10 times as toxic as GB.

Death usually occurs within 15 minutes after the absorption of a fatal dosage. The persistency of VX depends on the munitions and weather conditions. Heavily splashed liquid can persist for long periods under normal weather conditions. In very cold weather, VX can persist for months.

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<sup>114</sup> Headquarters, Department of the Army, Navy and Air Force, FM 3-9, *Potential Military Chemical/Biological Agents and Compounds*, Washington, DC, December 1990.

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## ***TAB C - METHODOLOGY FOR CHEMICAL INCIDENT INVESTIGATION***

The DoD requires a common framework for our investigations and assessments of chemical warfare agent incident reports, so we turned to the United Nations and the international community which had experience concerning chemical weapons, e.g., the United Nations' investigation of the use of chemical weapons during the 1980-88 Iran-Iraq war. Because the modern battlefield is complex, the international community developed investigation and validation protocols<sup>115</sup> to provide objective procedures for possible chemical weapons incidents. The standard that we are using is based on these international protocols and guidelines that includes:

- A detailed written record of the conditions at the site
- Physical evidence from the site such as weapons fragments, soil, water, vegetation, or human or animal tissue samples
- A record of the chain of custody during transportation of the evidence
- Testimony of eyewitnesses
- Multiple analyses
- Review of the evidence by an expert panel.

While the DoD methodology for investigating chemical incidents (Figure 9) is based on these protocols, the passage of time since the Gulf War makes it difficult to obtain certain types of documentary evidence, and physical evidence often was not collected at the time of an event. Therefore, we cannot apply a rigid template to all incidents, and each investigation must be tailored to its unique circumstances. Accordingly, we designed our methodology to provide a thorough, investigative process to define the circumstances of each incident and determine what happened. The major efforts in our methodology are:

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<sup>115</sup> "Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction," April 29, 1997. This Chemical Weapons Convention was opened for signature in Paris, France, on January 13, 1993. It has been signed by 165 States and ratified or acceded by 106 States (as of February 1998). It was signed by the U.S. on Jan 13, 1993 and ratified on April 25, 1997. Part XI of the Convention, "Investigations in Cases of Alleged Use of Chemical Weapons," details some of the procedures. Other protocols and guidelines were found in Methodology and Instrumentation for Sampling and Analysis in the Verification of Chemical Disarmament, The Ministry for Foreign Affairs of Finland, Helsinki, Finland, 1985; Verification Methods, Handling, and Assessment Of Unusual Events In Relation To Allegations of the Use of Novel Chemical Warfare Agents, Consultant University of Saskatchewan in conjunction with the Verification Research Unit of External Affairs and International Trade Canada, March 1990; and Handbook for the Investigation Of Allegations of the Use of Chemical or Biological Weapons, Department of External Affairs, Department of National Defense, Health and Welfare Canada, and Agriculture Canada, November 1985. US Army FM 3-4/USMC FMFM 11-9, NBC Protection, May 1992; Army FM 8-285/NAVY NAVMED P-5041/AFJMAN 44-149/MARINE CORPS FMFM 11-11 (adopted as NATO FM 8-285), Treatment Of Chemical Agent Casualties and Conventional Military Chemical Injuries, US Army FM 19-20, Law Enforcement Investigations, Headquarters , Department of The Army, November 25, 1985, and other DoD investigational procedures contributed ideas for the development of this DoD methodology.

- Substantiate the incident
- Document the medical reports related to the incident
- Interview appropriate people
- Obtain information available to external organizations
- Assess the results.

A case usually starts with a report of a possible chemical incident, usually from a veteran. To substantiate the circumstances surrounding an incident, the investigator searches for documentation from operational, intelligence, and environmental logs. This focuses the investigation on a specific time, date, and location, clarifies the conditions under which the incident occurred, and determines whether there is "hard," as well as anecdotal evidence. Alarms

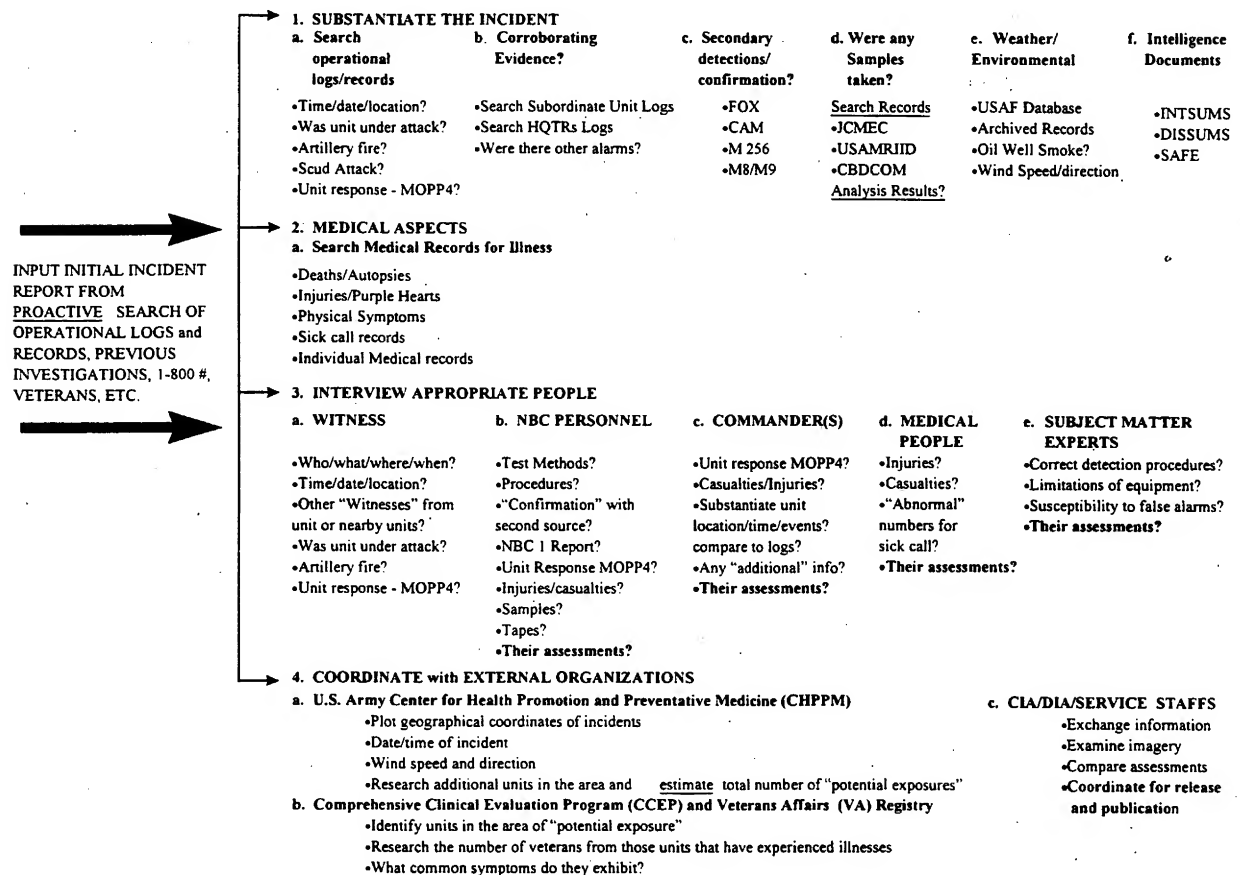


Figure 9. Chemical Incident Investigation Methodology

alone are not considered to be certain evidence of chemical agent presence, nor is a single individual's observation sufficient to validate a chemical agent presence. Additionally, the investigator looks for physical evidence that might indicate that chemical agents were

present in the vicinity of the incident, including samples (or the results of analyses of samples) collected at the time of the incident.

The investigator searches the medical records to determine if personnel were injured as a result of the incident. Deaths, injuries, sicknesses, etc., near the time and location of an incident may be telling. Medical experts should provide information about alleged chemical casualties.

Interviews of incident victims (or direct observers) are conducted. First-hand witnesses provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved, and are particularly important if physical evidence is lacking. NBC officers or personnel trained in chemical testing, confirmation, and reporting are interviewed to identify the unit's response, the tests that were run, the injuries sustained, and the reports submitted. Commanders are contacted to ascertain what they knew, what decisions they made concerning the events surrounding the incident, and their assessment of the incident. Where appropriate, subject matter experts also provide opinions on the capabilities, limitations, and operation of technical equipment, and submit their evaluations of selected topics of interest.

Additionally, the investigator contacts agencies and organizations that may be able to provide additional clarifying information about the case. These would include, but not be limited to:

- Intelligence agencies that might be able to provide insight into events leading to the event, imagery of the area of the incident, and assessments of factors affecting the case
- The DoD and Veterans' clinical registries, which may provide data about the medical condition of personnel involved in the incident.

## ***TAB D - CZECH AND FRENCH DETECTION EQUIPMENT***

### **CZECH DETECTION EQUIPMENT**

#### ***GSP-11 Automatic Nerve Agent Detector Alarm***

Item Description: The GSP-11 uses a photodetector to detect a color change on tape that has been treated with reagent. The presence of nerve agent is signaled by both an audible and visible alarm. The GSP-11 uses biochemical reaction (acetylcholinesterase inhibition) chemistry. As a result, the GSP-11 has the ability to detect both G- and V-type nerve agents... Because the acetylcholinesterase inhibition reaction is temperature sensitive, the GSP-11 has a thermostatically controlled electric heater that maintains a constant temperature between +33°C [91.4°F] and +38°C [100.4°F].<sup>116</sup>

The GSP-11 has two sensitivity ranges, E1 and E2. The E1 is the most sensitive and operates at intervals of 60 to 80 seconds. This range allows the GSP-11 to remain in operation for two hours on one reagent filling and each operating cycle lasts between 22 and 26 seconds. The air flow through the system using the E1 range is between 0.7 and 1 l/min. On the E2 sensitivity range the display interval lasts between five to eight minutes. This allows the unit to remain operational on one reagent filling for 10 to 12 hours. Each operating cycle lasts between 1.5 and 2.5 minutes and the air flow is reduced to 0.5 to 0.7 l/min.<sup>117</sup>

Technology: The GSP-11 has an electric pump that draws air over tape that has been soaked in Reagent Solution No. 1. Upon exposure to air, the tape is treated with a drop of Reagent Solution No. 2. If agent is present, a color change (indicated by comparison with a reference beam within the system) is detected by a photodetector, resulting in audible and visible alarms.<sup>118</sup>

False Responses/Interferents: Temperatures beyond the range of -30°C [-22°F] to +40°C [104°F] will cause the alarm to cease functioning or give a false alarm.<sup>119</sup>

Transport Requirements: May be operated using vehicle power or two rechargeable battery packs which require recharging every eight hours.<sup>120</sup>

Duration of Operation: The tape must be changed and the reagent reservoirs must be filled after eight hours of operation.<sup>121</sup>

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<sup>116</sup> Worldwide Chemical Detection Equipment Handbook, p. 76.

<sup>117</sup> Worldwide Chemical Detection Equipment Handbook, p. 76.

<sup>118</sup> Worldwide Chemical Detection Equipment Handbook, p. 76.

<sup>119</sup> Worldwide Chemical Detection Equipment Handbook, p. 76.

<sup>120</sup> Worldwide Chemical Detection Equipment Handbook, p. 76.

<sup>121</sup> Worldwide Chemical Detection Equipment Handbook, p. 76.



### ***CHP-71 Chemical Agent Detector***

**Item Description:** The CHP-71 is a lightweight, portable instrument used for the detection of chemical warfare agent contamination in the air, on terrain and on the surface of military equipment. A built-in motor pump draws an air sample at three l/min into the unit and through the detector tubes. Color changes in the detector tubes are compared to standards for the identification of the chemical agent. The color can also indicate the concentration level of the toxic agent identified. It can be operated inside or outside of a vehicle.<sup>122</sup>

**Technology:** Uses chemical reactions that precede an identifying color change for the identification of toxic agents. The color of the reaction layer is compared to a color chart.<sup>123</sup>

**Agents Detected:**<sup>124</sup>

Agent Class	Agents(s)	Detection Sensitivity	Response Time
Blister	H	1 mg/m <sup>3</sup>	3 minutes
Nerve	GB, GD and V Agents	5 x 10 <sup>-4</sup> mg/m <sup>3</sup>	3 to 7 minutes

**False Responses/Interferents:** High concentrations of NH<sub>3</sub> (Ammonia), SO<sub>2</sub> (Sulfur dioxide) or CL<sub>2</sub> (Chlorine) [can] trigger false positives.<sup>125</sup>

**Operational Information:** This instrument has an unlimited operational time in the vehicle. It can operate for six hours with one battery kit at temperatures greater than 0°C [32°F]. The preparation time at normal temperatures is two minutes and at temperatures below 15°C [59°F] is 10 minutes.<sup>126</sup>

**Operational Temperatures:** - 40°C [°F] to +50°C [122°F]<sup>127</sup>

### ***PCHL-90 Portable Chemical Laboratory***

**Item Description:** The PCHL 90 is a portable unit containing chemical reagents and appropriate laboratory equipment. It is designed to detect the presence of chemical agents on contaminated equipment, uniforms, clothing, terrain, water, food, fodder and various materials under field conditions. These chemical tests are also designed to detect residual contamination and the effectiveness of decontaminating solutions and mixtures

<sup>122</sup> Worldwide Chemical Detection Equipment Handbook, p. 94.

<sup>123</sup> Worldwide Chemical Detection Equipment Handbook, p. 94.

<sup>124</sup> Worldwide Chemical Detection Equipment Handbook, p. 94.

<sup>125</sup> Worldwide Chemical Detection Equipment Handbook, p. 94.

<sup>126</sup> Worldwide Chemical Detection Equipment Handbook, p. 94.

<sup>127</sup> Worldwide Chemical Detection Equipment Handbook, p. 94.

containing active chlorine. This portable laboratory is housed in a plastic box. Its cover is used as an area for performing the required chemical procedures.<sup>128</sup>

**System Components:** DETEHIT® Paper, Solvents, Stand (with chemical containers, protective equipment and decontaminates), Test Tubes (containing reagents) and Water Bag.<sup>129</sup>

**Technology:** The detection method used in this kit is based on chemical reactions that produce visible color changes.<sup>130</sup>

**Uses:** Intended for rapid quantitative and semi-quantitative analysis of toxic substances such as organophosphorus-based chemical warfare agents, herbicides, alkaloids and others. It checks the decontamination of materials, objects and terrain as well as solutions and mixtures which contain active chlorine. The kit is used to detect agents in water, soils, equipment, accessories, surfaces, air and food. It analyzes any undefined samples.<sup>131</sup>

**Agents Detected:**<sup>132</sup>

Agent Class	Agent(s)	Detection Sensitivity
Blister	H	5mg
Nerve	GB and GD	5 x 10 <sup>-3</sup> mg/m <sup>3</sup> (in air) 1 mg/m <sup>3</sup> (in water) 5x10 <sup>-3</sup> mg/m <sup>2</sup> (on surfaces)
	VA	5 x 10 <sup>-4</sup> mg/m <sup>3</sup> (in air) 5 x 10 <sup>-1</sup> mg/m <sup>3</sup> (in water) 1 x 10 <sup>-3</sup> mg/m <sup>2</sup> (on surfaces)

**Response Time:** The analysis can be completed in 30 minutes; reaction time is 15 minutes<sup>133</sup>

**False Positives/Interferents:** Theoretically, numerous agents can interfere. However, simultaneous use of all 10 reagents minimizes false responses.<sup>134</sup>

**Operational Information:** This kit is operational at temperatures above +5°C [41°F]. In case of lower temperatures, it can only be operated in heated rooms. It is capable of 200 full analyses. Clearing time is one hour.<sup>135</sup>

<sup>128</sup> Worldwide Chemical Detection Equipment Handbook, p. 106-107.

<sup>129</sup> Worldwide Chemical Detection Equipment Handbook, p. 106-107

<sup>130</sup> Worldwide Chemical Detection Equipment Handbook, p. 106-107

<sup>131</sup> Worldwide Chemical Detection Equipment Handbook, p. 106-107

<sup>132</sup> Worldwide Chemical Detection Equipment Handbook, p. 106-107

<sup>133</sup> Worldwide Chemical Detection Equipment Handbook, p. 106-107

<sup>134</sup> Worldwide Chemical Detection Equipment Handbook, p. 106-107

## FRENCH DETECTION EQUIPMENT

### *APACC Chemical Control Alarm Portable Apparatus*

**Item Description:** The APACC is a lightweight alarm unit comprised of the Portable Contamination Test Apparatus, known as the AP2C with an ADAC alarm unit that fits into the battery compartment of the AP2C. The AP2C is designed to detect and monitor for the presence of elemental phosphorous and sulfur in a given air sample. This detection technology allows the APACC to be used to detect the presence of nerve agents (organophosphorus compounds) and Mustard agents (sulfur containing compounds) in the atmosphere. The ADAC alarm unit is activated to... alarm for a predetermined concentration x time (Ct).<sup>136</sup>

Two Ct thresholds are available for each detection line (G agents and HD agents). The alarm signal can be transmitted to a remote alarm unit using a twin-core line, or to a synthesis cabinet. The alarm signals can be transmitted 1,000 meters using a standard conductor, but there is no limitation when signal amplification is used. To detect liquid contamination, a special sampling tip is used to collect the sample which is then heated to desorb the contamination into vapor form for detection. The AP2C monitor can operate autonomously from 12 to 24 hours depending on condition.<sup>137</sup>

**Technology:** The detection capability of the AP2C monitor is based on the principles of flame spectrophotometry.<sup>138</sup>

**Uses:** It can be used as a monitor for initial contamination hazard or as a monitor for residual contamination following decontamination. The APACC can be hand-held in its portable configuration, placed on the ground, or vehicle mounted using an anti-vibratile bracket.<sup>139</sup>

**Agents Detected:**<sup>140</sup>

Agent Class	Agent(s)	Detection Sensitivity	Response Time
Blister	HD	Minimum related to the concentration of the H mixture.	2 Seconds
	Neat and Thickened	0.4 mg/m <sup>3</sup>	2 Seconds
Nerve	GA, GB, GD and GF Neat and Thickened	0.1 mg/m <sup>3</sup>	2 Seconds
	VX	0.15 mg/m <sup>3</sup>	2 Seconds

<sup>135</sup> Worldwide Chemical Detection Equipment Handbook, p. 106-107

<sup>136</sup> Worldwide Chemical Detection Equipment Handbook, p. 148.

<sup>137</sup> Worldwide Chemical Detection Equipment Handbook, p. 148.

<sup>138</sup> Worldwide Chemical Detection Equipment Handbook, p. 148.

<sup>139</sup> Worldwide Chemical Detection Equipment Handbook, p. 148.

<sup>140</sup> Worldwide Chemical Detection Equipment Handbook, p. 148.

### ***TDCC Chemical Detection Control Kit***

**Item Description:** The TDCC is used to detect and identify chemical agent vapors in the air and liquid contamination in water and on various surfaces. A hand pump draws constant volume of ambient air through an absorbent paper disc mounted at the end of the pump via a special fitting. Toxic agents adhering to the paper are identified after exposure to one or more of eight reagents provided in the kit. The reagents produce a color change that is specific to each type of chemical agent. These reagents are stored in sealed glass vials until needed. The vials are broken in flexible plastic container which is designed to mix and pour off pre-determined volumes of reagents. Liquid contamination is identified using the detection paper included in the kit.<sup>141</sup>

**Technology:** The detection and identification capabilities are based on visible colorimetric chemical and biochemical reactions.<sup>142</sup>

**Uses:** It can be used to monitor and detect chemical warfare agents in the atmosphere, in water and on surfaces. It can also be used for the identification of these agents and provided a general estimate of their concentrations.<sup>143</sup>

**Agents Detected:**<sup>144</sup>

<b>Agent Class</b>	<b>Agents(s)</b>	<b>Detection Sensitivity</b>
Blister	HD and HN	1 mg/m <sup>3</sup> >0.15 mg/m <sup>3</sup>
Nerve	GA (chemical reaction)	3.5 mg/m <sup>3</sup>
	GB (chemical reaction)	0.10 mg/m <sup>3</sup>
	GA and GB (biochemical reaction)	0.001 mg/m <sup>3</sup>
	V agents (biochemical reaction)	0.001 mg/m <sup>3</sup>

**Response Time:** Five minutes; a four operations procedure covers the whole range of toxic detection. The TDCC requires two minutes for each detection. A full detection sequence requires 30 minutes if there is no information known about the nature of the toxic substance.<sup>145</sup>

<sup>141</sup> Worldwide Chemical Detection Equipment Handbook, p. 163.

<sup>142</sup> Worldwide Chemical Detection Equipment Handbook, p. 163.

<sup>143</sup> Worldwide Chemical Detection Equipment Handbook, p. 163.

<sup>144</sup> Worldwide Chemical Detection Equipment Handbook, p. 163.

<sup>145</sup> Worldwide Chemical Detection Equipment Handbook, p. 163.

# **Environmental Exposure Report**

## **Depleted Uranium in the Gulf**

The Office of the Special Assistant for Gulf War Illnesses is reporting on what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular report focuses on the use of, and exposures to, depleted uranium (DU). This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding DU use and exposures. Please contact my office to report any new information by calling:

**1-800-472-6719**

**Bernard Rostker**  
Special Assistant for Gulf War Illnesses  
Department of Defense

1998190-0000036

Last Update: July 31, 1998

Many veterans of the Gulf War have been experiencing a variety of physical symptoms, collectively called Gulf War illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1995 to investigate all possible causes. The Investigation and Analysis Directorate (IAD) of the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) assumed responsibility for these investigations on November 12, 1996, and has continued to investigate depleted uranium. Its interim report is contained here.

As part of the effort to inform the public about the progress of this effort, DoD is publishing (on the Internet and elsewhere) accounts related to possible causes of illnesses among Gulf War veterans, along with whatever documentary evidence or personal testimony was used in compiling the accounts. The report that follows is such an account.

# Environmental Exposure Report

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1-800-471-6779

Richard Roscher  
Special Assistant for Gulf War Illnesses  
Department of Defense

1997-10-10

Last Updated: July 23, 1998

Many veterans of the Gulf War have been experiencing a variety of physical symptoms collectively called Gulf War Illnesses. In response to veterans' concerns, the Department of Defense (DoD) established a task force in June 1992 to investigate all possible causes. The Investigation and Analysis Directorate (IAD) of the Office of the Special Assistant for Gulf War Illnesses (OSAGWII) assumed responsibility for these investigations on November 15, 1996, and has continued to investigate depleted uranium. Its interim report is contained here.

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1997-10-10

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## I. OVERVIEW<sup>1</sup>

The Gulf War was the arena for the first battlefield use of armor-piercing munitions and reinforced tank armor incorporating depleted uranium (DU). This very dense metal is a by-product of the process by which natural uranium is "enriched" with the addition of radioactive isotopes taken from other uranium. The leftover uranium, drained of 40% of its original radioactivity, is called "depleted uranium," or DU.

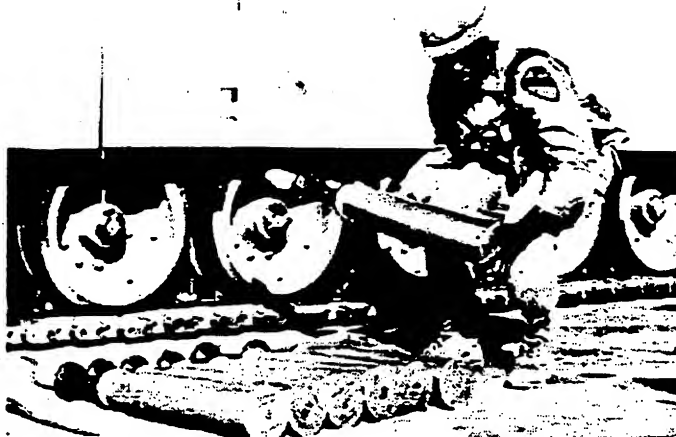


Figure 1 - Abrams tank and DU sabot rounds

Depleted uranium played a key role in the overwhelming success of US forces during the Gulf War: Machined into armor-piercing 120mm DU 'sabot' rounds (Figures 1 and 2), DU penetrators were called "silver bullets" by tankers, who quickly recognized the tremendous lethal advantage these rounds provided against enemy tanks. The extreme density of the metal and its

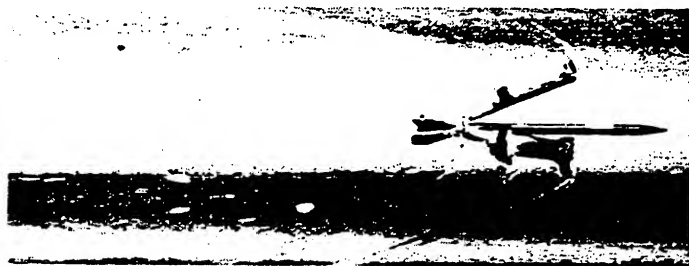


Figure 2 - DU round discarding its sabot

self-sharpening properties make DU a formidable weapon; its projectiles slice through thicker, tougher armor at greater ranges than other high-velocity rounds. In addition, DU is pyrophoric—upon striking armor, small particles break off and combust spontaneously in air, often touching off explosions of fuel and munitions.

DU was also used to enhance the armor protection of US tanks. In one noteworthy incident, an M1A1 Abrams Main Battle Tank, its thick steel armor reinforced by a sandwiched layer of DU, rebuffed a close-in attack by three Iraqi T-72 tanks. After deflecting three hits from the Iraqi tanks, the Abrams' crew dispatched the T-72s with a single DU round to each (an expanded version of the encounter can be found in Tab F). Similarly, Air Force A-10 "tank-busters" and Marine Corps Harrier close air support aircraft fired 30mm and 25mm DU rounds, respectively, with deadly effect against Iraqi armor (see Tab F for a description of DU use in the Gulf).

During the Gulf War, DU helped US forces fight more effectively and defend themselves more confidently. American tankers and A-10 pilots destroyed thousands of Iraqi combat vehicles without the loss of a single US tank to enemy fire. Since the Gulf War, DU's battlefield effectiveness has encouraged its steady proliferation into the arsenals of allies and adversaries.

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<sup>1</sup> A Glossary and List of Acronyms is located at Tab A.

alike. There is little doubt, therefore, that DU will be used against our troops in some future conflict.



Figure 3 – M1A1 in the Gulf

While DU's combat debut showed the metal's clear superiority for both armor penetration and armor protection, its chemical toxicity—common to all forms of uranium and similar to other heavy metals—and its low-level radiological properties gave rise to concerns about possible combat and non-combat health risks associated with DU use. The issues to be addressed in this report are: did DU pose an unacceptable health risk to American troops; were personnel trained to recognize and communicate that risk; and were troops, once exposed to DU, adequately monitored and treated?

To many veterans and members of the public, the term “exposure,” especially when associated with the word “radiation,” signifies that adverse health effects will follow. In fact, exposure in the present case is used to describe events and situations where soldiers came into contact with depleted uranium fragments and particles formed when DU struck armor targets or “slow cooked” in fires. “Exposure” in the current context is better understood if equated with most people's daily “exposure” to automobile exhaust, second-hand smoke, or similar noxious or potentially toxic substances. In minute quantities, such exposures will not produce harmful effects; however, when certain thresholds are exceeded, adverse health effects might result.

This report examines a variety of exposures that occurred during and after the Gulf War. The report begins with a short, but important lesson on DU—what it is and the potential health risks of its chemical and radiological properties (see DEPLETED URANIUM—A SHORT COURSE, page 11). The report then describes DU exposures that occurred during the Gulf War, and relates those exposures to possible health effects (see ASSESSMENT OF POTENTIAL HEALTH EFFECTS FROM DU USE IN THE GULF THEATER, 1990-1991, page 20). Next, the report addresses recent environmental studies of various DU munitions, environmental assessments of DU contamination on the battlefield, results of current medical studies, future monitoring efforts, and on-going and planned research (see FOLLOW-UP, page 29). After the Follow-up, the report presents some lessons learned since the Gulf War (see LESSONS LEARNED, page 37), addressing pre-Gulf War training shortfalls, and recommending steps DoD can take to better prepare troops to operate in environments where they might encounter DU contamination. The Conclusion (see CONCLUSION, page 42) summarizes the contents of the report, describes ongoing research and medical follow-up programs, and relates key findings and conclusions based on evidence analyzed to date.

This investigation, and medical and scientific research to date, have not established any relationship between DU exposures and the undiagnosed illnesses presented by some Gulf War veterans. These efforts are ongoing, and this office will continue to apply lessons learned from the investigation and research efforts to safeguard the health of our troops.

Investigators from the Office of the Special Assistant have interviewed hundreds of Gulf War combatants and eyewitnesses, reconstructed numerous operations, consulted with subject matter experts, and researched the most current body of knowledge regarding DU's medical effects and environmental impact. The investigation classifies possible DU exposures into three Levels, encompassing 13 separate activities, shown in Table 1 (see page 8). These Levels are based on initial estimates about the extent of the exposures. For each Level, Table 1 provides a description of the activity, a current estimate of the number of soldiers involved, the duration of the exposure, and the personal protective equipment used, if any.

The investigation includes incidents in which US tanks mistakenly fired DU armor-piercing rounds into other US combat vehicles, exposing surviving crewmen in those vehicles to wounds from DU fragments and/or inhalation and ingestion of particles formed when DU munitions penetrate armor, especially tank armor. During these "friendly fire" incidents, personnel rushing to evacuate and rescue fellow troops from stricken vehicles may have also been directly exposed to DU. These immediate and direct exposures are part of Level I exposures (see Tab G).

A second, lower level of exposures to DU occurred after combat as explosive ordnance disposal (EOD) personnel entered DU-contaminated vehicles to remove unexploded munitions. In addition to EOD personnel, battle damage assessment teams (BDAT), radiation control (RADCON) teams, and salvage crews worked in and on the damaged or destroyed vehicles as they were processed for repair or disposal. Also classified with this group would be personnel involved in clean-up and recovery operations in the North Compound of Camp Doha, Kuwait, following the motor pool fire in which DU munitions detonated and burned. These personnel, and others who may have come into direct contact with the dust-like residue of expended DU rounds, are categorized under the Level II exposure category (see Tab G).

A third category of DU exposure, Level III, also discussed in Tab G, defines personnel whose exposure to DU was short-term and generally very low. These exposures may have occurred as personnel passed through and inhaled smoke from burning DU, casually handled spent DU penetrators, or briefly entered DU-contaminated vehicles on the battlefield or in salvage yards.

These three exposure categories are not exclusive. Given the complexity of combat operations during the Gulf War and the wide variety of post-combat assignments, there are other possible DU-exposure scenarios which could overlap categories. The purpose of this report is to relate the documented incidents during which exposure to DU was a distinct possibility, and to discuss what is currently known about the potential health effects resulting from those exposures.

Table 1 - Incident Summary

Exposure Classifications: Levels and Scenarios	Number of Personnel	Duration of Exposure	Personal Protection Worn
<b>Level I</b>			
Soldiers in or on vehicle at the time it was penetrated by a DU munition.	≈113*	Minutes to Days**	None
Soldiers who entered US vehicles immediately after friendly fire DU impacts to rescue occupants.	≈30-60*	Minutes	None
<b>Level II</b>			
Explosive Ordnance Disposal (EOD) and unit personnel who downloaded equipment and munitions from DU-contaminated systems.	≈30-60*	~ 1 hour per vehicle	None
Unit maintenance personnel who performed maintenance on or in DU-contaminated systems.	≈30-60*	~ 1 hour per vehicle	None
Logistics Assistance Representatives (LARs) who inspected DU-contaminated Systems to determine reparability.	≈6-12	~ 1 hour per vehicle	Some Wore PPE***
Battle Damage Assessment Team (BDAT) members who examined US combat vehicles damaged and destroyed by DU.	12	3 hours per vehicle	Most Wore PPE
144 <sup>th</sup> Service and Supply Co. personnel who processed damaged equipment, including some with DU contamination.	27	Various	None
Radiation Control (RADCON) team members.	10-12	Hours	PPE
Personnel exposed to DU contamination during clean-up operations at Camp Doha's North Compound.	≈600*	Hours	None
<b>Level III</b>			
Personnel exposed to smoke from burning DU rounds at Camp Doha.	hundreds	Minutes	None
Personnel exposed to smoke from burning Abrams tanks.	unknown	Minutes	None
Personnel who entered DU-contaminated equipment.	unknown	~5 to 10 minutes per vehicle	None
Personnel exposed to smoke from DU-impacted Iraqi equipment.	unknown	Minutes	None

\*. Number is not final, under investigation.

\*\* Most soldiers were removed from friendly fire vehicles within minutes. However, we have received reports of soldiers driving around in minimally damaged Bradley Fighting Vehicles (BFVs) for several days.

\*\*\*Personal Protective Equipment includes surgical mask, coveralls, boots and gloves.

Dose and toxicity determine health effects. The US Army Center for Health Promotion and Preventive Medicine (CHPPM) is concentrating on determining possible DU intakes by Level I soldiers, who were most exposed. Initial estimates represent an upper bound to exposure, commonly called the "worst case," based on the limited available test data for DU sabot rounds which penetrated DU armor. In this report, "worst case" refers to conditions that are thought to produce a maximum exposure to DU. These estimates indicate that the radiological risk for these events is well within current regulatory limits for industrial workers. It should be cautioned that these dose estimates are very preliminary, requiring additional testing to fill data gaps, require further refinement of dose estimates, and will be influenced by current research about DU's medical effects.

Since 1993, the Department of Veterans Affairs has been monitoring 33 vets who were seriously injured in friendly fire incidents involving depleted uranium. These veterans are being monitored at the Baltimore VA Medical Center. While these veterans have very definite medical afflictions resulting from their wartime injuries, they are not sick from the heavy metal or radiological toxicity of DU. About half of this group still have depleted uranium metal fragments in their bodies. Those with higher than normal levels of uranium in their urine since monitoring began in 1993 have embedded DU fragments. These veterans are being followed very carefully and a number of different medical tests are being done to determine if the depleted uranium fragments are causing any health problems. The veterans being followed who were in friendly fire incidents but who do not have retained depleted uranium fragments, generally speaking, have not shown higher than normal levels of uranium in their urine. For the 33 veterans in the program, tests for kidney function have all been normal. In addition, the reproductive health of this group appears to be normal in that all babies fathered by these veterans between 1991 and 1997 had no birth defects.

The DoD and Department of Veterans Affairs recently instituted a new medical follow-up program to evaluate all individuals who were in or on vehicles that were struck by friendly fire, as well as those who worked around DU-contaminated vehicles. These individuals were less exposed than the 33 in the original program, but potentially more exposed than the general military population. While their DU exposures are unlikely to have exceeded the threshold levels at which health effects might be observed, prudence dictates that they be evaluated to establish any residual body burden of DU. Veterans whose known exposures caused them to be classified as Level I or Level II exposure participants who worked on DU-contaminated equipment (described further on page 8 and in Tab G) will be notified of their exposures and offered a medical evaluation. They will also receive the letter and DU information shown in Tab K, DU Notification and Medical Follow-up.

To illustrate specific examples of DU exposures that occurred during the war, this report draws upon several incidents during which US military personnel were exposed or potentially exposed to DU through inhalation, ingestion, wound or bare skin contact. Where the essential facts have been established, those incidents have been investigated and are reported here. Where the reports of DU exposure are incomplete or remain unsubstantiated, the investigation continues.

Based on data developed to date, the Office of the Special Assistant believes that while DU can pose a chemical toxicity and radiological hazard under specific conditions, the available evidence does not support claims that DU caused or is causing the undiagnosed illnesses some Gulf War veterans are experiencing.

## **Methodology**

The Office of the Special Assistant's investigation of DU as a potential cause of Gulf War illnesses adopted a health risk assessment methodology patterned on that used by the US Environmental Protection Agency. This process, outlined in Tab D, estimates the health risk from contaminant concentrations, site exposure, and contaminant toxicity characteristics. It consists of four steps: Hazard Identification, Toxicity Assessment, Dose Assessment, and Risk Characterization, defined below:

- Hazard Identification - who was exposed, and how? Which incidents warrant a full investigation?
- Toxicity Assessment - what are the known medical effects of human exposure to DU? At what levels of exposure do these effects occur? How can the effects be mitigated?
- Dose Assessment - how much DU were the troops exposed to? What chemical or radiological doses do these intakes represent?
- Risk Characterization - using validated toxicity and dose information, what medical effects can be anticipated? How serious are those effects? How can the effects be communicated to those affected?

Performing this assessment for DU involves the cooperative efforts of several organizations, specifically;

- The Office of the Special Assistant for Gulf War Illnesses - Hazard Identification and Risk Characterization.
- RAND Corporation - Toxicity Assessment.
- US Army Center for Health Promotion and Preventive Medicine (CHPPM) - Dose Assessment (Exposure and Risk Assessment).
- VA DU medical surveillance program - communication with those affected.

As described above, the Office of the Special Assistant for Gulf War Illnesses has focused its investigation on determining what happened, what exposures may have occurred, and who may have been exposed. Exposures have been subdivided into levels and scenarios so they can be related to toxicity and dose information.

With a view toward developing a toxicity assessment, the RAND Corporation is conducting an independent review of available medical and scientific literature on DU's known medical and health effects. RAND's review focuses on the health effects of internalized depleted uranium and discusses the levels of external exposure.



The US Army Center for Health Promotion and Preventive Medicine (CHPPM) is performing the exposure and risk assessment by estimating the amount of DU which may have been taken into the body for each of the 13 exposure groups. Since direct measurements of the radiation and chemical doses were not taken at the time the incidents occurred, CHPPM is using the best available data, combined with scientific and engineering principles, to develop its exposure and risk assessments. Specific CHPPM activities include:

- Reviewing test data on the behavior of DU during fires and impacts with armor;
- Evaluating the usefulness and appropriateness of that data in modeling the amount of DU a soldier might take in through inhalation, ingestion, or wound contamination;
- Identifying data gaps; and
- Performing estimates of the radiological and chemical doses for each of the 13 activities involving possible DU exposure.

Finally, the Office of the Special Assistant will combine the results of CHPPM's dose assessments and RAND's medical review to characterize the risks to health, and to develop clear, concise discussions of those risks for each of the 13 exposure scenarios and events. That work is currently in progress.

The final, comprehensive report on DU's potential role in Gulf War illnesses, combining all these studies and the screening results from the DoD-VA expanded medical follow-up, is expected in approximately one year.

## **II. DEPLETED URANIUM—A SHORT COURSE**

The following sections discuss DU's chemical and radiological properties, the ways those properties may affect human health, and the principles and standards for protecting soldiers and the public from harm. These discussions address DU's chemical toxicity, which is the metal's property of most concern, followed by a summary of DU's radiological toxicity.

It should be emphasized that DU's chemical and radiological properties, and their health and environmental implications, had been carefully evaluated as part of the standard acquisition, test, and evaluation process for new weapons systems. Throughout the development of the DU weapons program, the DOD has adhered to a highly regulated development and procurement process that involved extensive hazard assessments, tests, and evaluations. A comprehensive discussion of the DU research and development program, including specific test and evaluation efforts, is found in Tab E, Development of DU Munitions and in Tab L, Research Report Summaries.

## A. Health Effects From the Chemical Toxicity of Depleted Uranium

### 1. Chemical Properties of DU

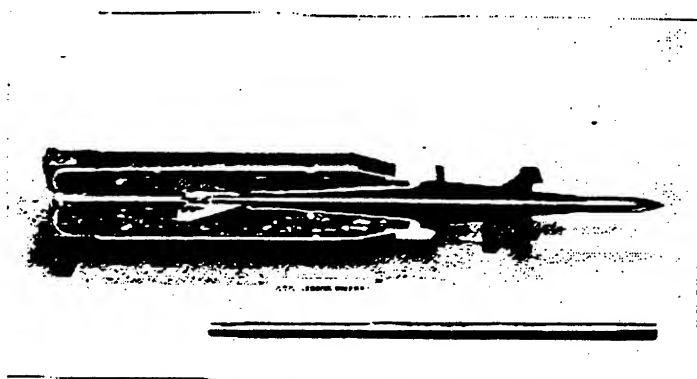


Figure 4 - Cutaway of DU sabot round

Uranium is all around us. It is a heavy metal similar to tungsten, lead, and cadmium, occurring in soils at an average concentration of 3 parts per million, equivalent to a tablespoon of uranium in a truckload of dirt.<sup>2</sup> All of us take in uranium every day from the air we breathe, the water we drink, and the foods we eat. On average, each of us takes in 1.9 micrograms (about two millionths of a gram) of uranium a day from food and water,

and inhales a very small fraction ( $7 \times 10^{-3}$  or 0.007) of a microgram every day.<sup>3</sup>

DU's ability to self-sharpen as it penetrates armor is the primary reason why DU is a more potent weapon than alternate tungsten munitions, which tend to mushroom upon impact. Fragments and uranium oxides are generated when DU rounds strike an armored target. The size of the particles varies greatly; larger fragments can be easily observed, while very fine particles are smaller than dust and can be inhaled and taken into the lungs. Whether large enough to see, or too small to be observed, DU particles and oxides contained in the body are all subject to various degrees of solubilization—they dissolve in bodily fluids, which act as a solvent.

The solubility of uranium varies greatly depending on the particular compound—or form of uranium—and the solvent. The human body's natural fluids, which are water-based, provide the solvent that acts on DU that has entered the body. In this report, references to "soluble" and "insoluble" forms of depleted uranium are relative generalizations about depleted uranium's overall solubility; over time, all uranium is soluble. The three uranium oxides of primary concern ( $\text{UO}_3$ ,  $\text{UO}_2$ , and  $\text{U}_3\text{O}_8$ ) all tend to dissolve slowly (days for  $\text{UO}_3$  to years for  $\text{UO}_2$  and  $\text{U}_3\text{O}_8$ ) in bodily fluids.<sup>4</sup> Once dissolved, uranium may react with biological molecules and, in the form of the uranyl ion, may exert its toxic effects. Those toxic effects are: cellular necrosis (death of cells) in the kidney and atrophy in the tubular walls of the kidney resulting in a decreased ability to filter impurities from the blood.<sup>5</sup>

<sup>2</sup> Toxicological Profile for Uranium, Draft for Public Comment. Atlanta, GA: US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, September 1997, p. 1.

<sup>3</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report, Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 111.

<sup>4</sup> Bioassay Programs for Uranium, An American National Standard, HPS N13.22-1995, Health Physics Society; McLean, VA; October 1995, p. 13, 38.

<sup>5</sup> Toxicological Profile for Uranium, Draft for Public Comment. Atlanta, GA: US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, September 1997, p. 15.

## 2. Chemical Effects

Once dissolved in the blood, about 90% of the uranium present will be excreted by the kidney in urine within 24-48 hours.<sup>6</sup> The 10% of DU in blood that is not excreted is retained by the body, and can deposit in bones, lungs, liver, kidney, fat and muscle. Insoluble uranium oxides, if inhaled, can remain in the lungs for years, where they are slowly taken into the blood and then excreted in urine.

Although heavy metals are not attracted to single biological compounds, they are known to have toxic effects on specific organs in the body. Previous research has demonstrated that the organ that is most susceptible to damage from high doses of uranium is the kidney. The uranyl-carbonate complexes decompose in the acidic urine in the kidney. This reaction forms the basis for the primary health effects of concern from uranium. The effects on the kidney from uranium resemble the toxic effects caused by other heavy metals, such as lead or cadmium.

So far, very few Gulf War veterans have been diagnosed with types of kidney damage in which DU would be on the list of possible causative agents. Diabetes and lupus would be the most likely causes on the list, however. Among the first 20,000 veterans who were evaluated in the CCEP, there were only 25 individuals (0.1%) who were diagnosed with these types of kidney damage. These included 13 individuals with glomerulonephritis and 12 individuals with renal insufficiency.<sup>7</sup> None of these 25 individuals were among the group of 33 veterans with the highest DU exposures who have been followed in the Baltimore VA program. The rates of these diagnoses in this self-selected population are consistent with the rates of similar kidney problems in the general US population.

## 3. Chemical Toxicity Standards

For uranium, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established protection standards for workers based on the chemical toxicity to the kidney. The standards are based on the assumption that they will provide adequate protection for workers over a normal working (40 hours per week) lifetime. Additionally, levels for short-term exposures are also defined to limit acute exposure effects. The Permissible Exposure Limits (PELs) listed in Table 2 are from the Code of Federal Regulations dealing with occupational exposures to toxic and hazardous substances. Table 2 is intended only for a general comparison of the relative toxicity of the

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<sup>6</sup> Naomi Harley, Earnest Foulkes, Lee Hilborne, Arlene Hudson, C. Ross Anthony, "A Review of the Scientific Literature as it Pertains to Gulf War Illnesses, Volume V: Depleted Uranium, Draft," RAND, National Defense Research Institute, Washington DC, June 29, 1998, p. 13.

<sup>7</sup> Stephen P. Joseph and the Comprehensive Clinical Evaluation Team, A Comprehensive Clinical Evaluation of 20,000 Persian Gulf War Veterans, Military Medicine, Vol. 162, March 1997, p. 149-155.

various metals. Although the PEL was derived for natural uranium, the chemical effects of the various isotopes of uranium are expected to be identical.

Table 2 - Comparison of OSHA PELs for Metals from Inhalation Exposures.<sup>8</sup>

Element	Soluble Compounds (mg/m <sup>3</sup> )	Insoluble Compounds (mg/m <sup>3</sup> )
Lead*	0.05	0.05
Cobalt - metal, dust and fume (as Co)*	0.1	0.1
Uranium	0.05	0.25
Nickel	1	1
Tungsten	1	5
Mercury	0.01	
Titanium Dioxide		
Total dust*		15

\* No distinction is made between soluble and insoluble compounds.

In addition to OSHA's limits, ACGIH has established a Threshold Limit Value (TLV<sup>®</sup>) of 0.2 mg/m<sup>3</sup> (for both soluble and insoluble compounds). For brief periods of exposure, ACGIH has set a short-term exposure limit (STEL)(an average concentration over a 15 minute period that allows for brief excursion above the TLV) of 0.6 mg/m<sup>3</sup>.<sup>9</sup> PELs and TLVs<sup>®</sup> are based on the principle that there is a threshold below which no adverse health effects occur. As the exposure increases above the threshold, the adverse health effect becomes more severe. PELs and TLVs<sup>®</sup> are called time-weighted-average values because they are averaged over an 8-hour workday, for a 40-hour workweek over a working lifetime.

The OSHA PELs and ACGIH TLVs<sup>®</sup> were intended to apply to the common workplace, not to the battlefields of Desert Storm. Nevertheless, these limits provide a set of guidelines for use as a starting point in evaluating hazards. However, since only limited environmental data are available from the operational environment, the guidelines serve as reference points for comparison with experimental data.

#### 4. Implications for the Military

DU exposures for the Level II and Level III exposure categories are believed to be well below levels expected to produce either temporary or permanent kidney damage. The friendly fire victims (Level I exposures) are believed to have had the highest exposures during the Gulf War (Reference Section III.B.1.c.). It is impossible to assess temporary DU-related kidney

<sup>8</sup> 29 CFR 1910.1000 Table Z-1 Limits for Air Contaminants; 29 CFR 1915.1000 Table Z; and 29 CFR 1910.1025 Lead.

<sup>9</sup> 1998 TLVs and BEIs, Threshold Limit Values for Chemical Substances and Physical Agents, Biological Exposure Indices, American Conference of Governmental Industrial Hygienists.

dysfunction in these soldiers immediately following their accidents, because traumatic injuries and major surgeries may also cause temporary renal abnormalities. In addition, routine urinalysis tests do not detect subtle, early renal damage that might be associated with DU heavy metal toxicity. However, no kidney abnormalities have been documented in any of the 33 veterans studied in the Baltimore VA program, including during their most recent examinations in 1997.

## **B. Health Effects From the Radiological Toxicity of Depleted Uranium**

### **1. Radiological Properties of DU**

Depleted uranium—described above as a metallic remnant of one of several processes that begin with uranium ore—is composed of three isotopes of uranium ( $^{234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ ). Depleted uranium, like all uranium and other elements, is composed of atoms; the basic building block of nature. Atoms consist of atomic particles called neutrons (neutral particles), protons (positively charged particles), and electrons (negatively charged and relatively massless). For any element, like uranium, the number of protons and electrons determine the chemical properties. Atoms of the same element can have different numbers of neutrons. These different atoms of the same element are called isotopes. Isotopes of an element have the same chemical properties, but may have different nuclear or radiological properties. In nature, uranium consists of the isotopes  $^{234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$  in a certain ratio. Depleted uranium has a lower content of  $^{234}\text{U}$  and  $^{235}\text{U}$ , which have been removed in the enrichment process.

The number of heavy particles (protons and neutrons) in the nucleus of an atom determines the stability of the element. Unstable elements 'decay' through a nuclear transformation process into new elements called progeny or daughter products. Each daughter product has a lower atomic weight than the unstable parent isotope. This process of decay—radioactivity—emits one or more forms of ionizing radiation (among them, alpha particles, beta particles, neutrons, X-rays, or gamma rays) during each nuclear transformation. This decay process continues until a stable (non-radioactive) element is produced. For example, after completing several stages of the radioactive decay process,  $^{238}\text{U}$  becomes lead. A more thorough description of the origins of depleted uranium can be found at Tab C.

### **2. Radiological Effects**

As it decays, DU emits alpha, beta, and gamma radiation. An understanding of how DU's emissions may cause health effects can be drawn from existing knowledge of how radiation, in general, causes health effects.

Radiation is everywhere. People live their lives being bombarded by gamma rays, neutrons, and charged particles produced by materials in nature and even in their own bodies. This ever-present background radiation has persisted for as long as the earth has existed. Humans have evolved and developed in this ionizing radiation environment.

In discussing health effects relating to ionizing radiation, the term "dose" is used. "Dose" comes from the early medical use of x-rays, much as a dose of medicine is measured in grains or ounces. It refers to the amount of radiation energy absorbed by an organ, tissue, or cell, measured in rems.<sup>10</sup> Today, the average American receives a dose of 0.3 rem every year from natural sources—radioactive materials in rocks and soil, cosmic radiation, radon, and radioactivity in our bodies. Over a 70-year lifetime, the average dose is 21 rems. In some areas of the world, people receive much higher doses from background radiation. For example, in areas of India and Brazil the ground is covered with monazite sand, a radioactive ore. Radiation exposure rates there are many times the average background levels elsewhere. People who live in these areas receive doses of up to about 0.7 rem each year from the gamma radiation alone.<sup>11</sup> These levels combined with the other sources of background radiation (cosmic rays, radon, etc.), cause average doses that are about three times more than the US average. Yet these people show no unusual rates of cancer or other diseases linked to radiation.<sup>12</sup>

The effects of ionizing radiation can be categorized as either prompt or delayed, based on the time frame in which the effects are observed. Prompt effects, like rapid death, occur when high doses are received in a short period of hours to weeks. Delayed effects, such as cancer, can occur when the combination of dose and dose rate is too small to cause prompt effects. Both animal experiments and human exposures to high levels of radiation show that ionizing radiation can cause some cancers.<sup>13</sup> All of the observed effects of ionizing radiation in humans occur at relatively high doses. At the low doses that are of interest to radiation workers and the general public (that is, below a few rems), studies to date are inconclusive.<sup>14</sup> Although adverse health effects have not been observed at low doses, the carcinogenic nature of ionizing radiation makes it wise to limit the dose.

For low-doses, there is no reliable data relating dose to health effects or showing a threshold, or minimum, level for cancer. Because of this, experts who study radiation effects have decided that the results from high-dose, high-dose-rate studies must be used to control the low-dose, low-dose-rates experienced by workers and the public. The easiest way to do this is to assume that no effects occur at zero dose. Also, since the rate at which effects occur is extrapolated from higher doses, it is also assumed that the effect increases linearly with dose. These two assumptions are known as the "linear-dose-response, non-threshold" (LNT) hypothesis. This implies that the same number of additional cancers would occur from exposing 100 persons to 100 rems, or 10 thousand persons to 1 rem, or 10 million persons to 0.001 rem. No threshold

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<sup>10</sup> A rem (roentgen equivalent in man or mammal) is a measurement of the relative effectiveness of a radiation dose. See Glossary at Tab A for a more detailed definition.

<sup>11</sup> BEIR V, Health Effects of Exposure to Low Levels of Ionizing Radiation, National Academy Press, Washington, D.C., 1990, p. 384.

<sup>12</sup> BEIR V, Health Effects of Exposure to Low Levels of Ionizing Radiation, National Academy Press, Washington, D.C., 1990, p. 385.

<sup>13</sup> BEIR V, Health Effects of Exposure to Low Levels of Ionizing Radiation, National Academy Press, Washington, D.C., 1990, p. 385.

<sup>14</sup> BEIR V, Health Effects of Exposure to Low Levels of Ionizing Radiation, National Academy Press, Washington, D.C., 1990, p. 385.

effects have ever been reliably observed in humans below about 10 rems<sup>15</sup>, but reports from the Japanese atomic bomb survivor studies conclude that the location and reality of such a threshold, if one does exist, are difficult to assess.<sup>16</sup>

### 3. Radiological Protection Standards and Guidelines

Ionizing radiation offers many benefits to society in medical diagnosis and treatment, greenhouse-gas-free power, food safety, etc. At the same time, it carries risks to safety and health as discussed above.

Within the first 30 years after the discovery of x-rays, standards were developed for the measurement of radiation. At about the same time, acceptable levels of dose were set. The first level, known as the 'tolerance dose', or that amount of radiation that could be tolerated, was set at one-tenth of a unit (about 0.1 rem in today's units) per day for 300 days a year.

From World War II to the early 1980s, radiation dose limits were adjusted downward in response to increased concern about radiation effects, the increased uses of radiation, and because improved radiation protection technologies appeared. The National Council on Radiation Protection and Measurements (NCRP, established in the 1930s) developed the recommended changes for the United States. During that time, the dose limit was reduced from three-tenths of a rem in a six-day period in 1946 to 5 rems per year in the mid-1950s. Also, a limit for the public was set at one-tenth of the worker limit to provide an additional margin of safety.

Research does not show a clear threshold dose for cancers from radiation, so the small risk per person at low doses had to be considered in relation to the large number of workers who were receiving those doses.<sup>17</sup>

The NCRP adopted three radiation protection principles: (a) no practice shall be carried out unless it produces a positive net benefit (sometimes called justification); (b) all exposures shall be kept as low as reasonably achievable (ALARA), economic and social factors being taken into account (called optimization); and (c) the dose equivalent to individuals shall not exceed the recommended limits (called limitation). These principles work together to protect against both prompt and delayed effects in large groups of workers and the public.

In 1993, the NCRP released a new set of national recommendations based on International Council on Radiation Protection's (ICRP) 1990 recommendations. Those limits for non-threshold effects differ slightly from the earlier recommendations: 50 rems per year to any tissue

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<sup>15</sup> Adverse Reproductive Outcomes in Families of Atomic Veterans: The Feasibility of Epidemiologic Studies, Institute of Medicine, 1995, p. 23-24.

<sup>16</sup> Otake, M. et. al., Radiation Effects Research Foundation Technical Report RERF TR 16-87, Severe Mental Retardation Among the Prenatally Exposed Survivors of the Atomic Bombing of Hiroshima and Nagasaki: a Comparison of the T65DR and DS86 Dosimetry Systems, 1987.

<sup>17</sup> Limitation of Exposure to Ionizing Radiation, Report No. 116, National Council of Radiation Protection and Measurements, Bethesda, MD, 1993, p. 33.

or organ and 15 rems to the lens of the eye to avoid cataract formation. The recommended occupational limits on whole-body doses (total effective dose equivalent), first set at 5 rems per year in 1958, are now set at no more than 5 rems in any one year and a lifetime average of no more than 1 rem per year.<sup>18</sup>

Occupational radiation exposure limits for federal agencies are currently established in "Radiation Protection Guidance to Federal Agencies for Occupational Exposure," 52FR 1717, signed by President Reagan on January 20, 1987. The Nuclear Regulatory Commission implemented that guidance in its regulations on radiation protection (Title 10, Code of Federal Regulations, Part 20). These limits apply to all licensed uses of radioactive material under NRC's jurisdiction. Similarly, other Federal agencies as a matter of policy and directive, including the DoD in DODI 6055.8, Occupational Radiation Protection Program, also observe this guidance.<sup>19</sup>

The current established protection standards are:<sup>20</sup>

- 5 rems in a year for workers (to protect against cancer).
- 50 rems in a year for workers to any organ (to protect against threshold effects, such as radiation burns, etc.).
- 50 rems in a year to the skin or to any extremity.
- 15 rems in a year to the lens of the eye (to protect against cataracts).
- 0.1 rem in a year (70-year lifetime) for members of the public.

These limits are in addition to the radiation doses a person normally receives from natural background, medical testing and treatment, and other sources.

Because any amount of radiation dose is assumed to lead to some health effects (regardless of how small), guidance also requires that doses be kept "as low as reasonably achievable" (ALARA). This means that one should try to reduce doses to as far below the limits as reasonably possible.

For DU, the annual occupational limit of 5 rems was selected as the benchmark for evaluating the consequences of exposure in the Gulf War. This benchmark has been shown to be well below the levels at which any effects from ionizing radiation have ever been observed in people. Furthermore, the limit is consistent with the safe practices in the radiation industry.

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<sup>18</sup> Limitation of Exposure to Ionizing Radiation, Report No. 116, National Council of Radiation Protection and Measurements, Bethesda, MD, 1993, p. 34.

<sup>19</sup> "Occupational Radiation Protection Program, Department of Defense Instruction 6055.8, revised May 6, 1996.

<sup>20</sup> Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation, Subpart C, 20.1201: Occupational Dose Limits for Adults; and Subpart D, 20.1301, Dose Limits for Individual Members of the Public.



#### 4. Implications for the Military

External radiation exposures may occur when personnel are close to DU due to its beta and gamma radiation. Studies of external radiation measurements inside tanks show that the tank commander, gunner, and loader receive a radiation dose rate of 0.00001-0.00002 rem/hour, an amount which is somewhat less than the average natural background rate of about 0.00003 rem/hour.<sup>21</sup> The tank driver may receive slightly higher dose rates of 0.00003 (gun pointed forward) to 0.00013 rem/hour (bustle fully loaded with DU ammunition pointed forward), when the driver's hatch is open.<sup>22</sup> This means the driver inside a fully loaded "heavy armor" tank (a model using DU armor panels) continuously, 24 hours a day, 365 days a year, would still receive a dose of less than 25% of the current, annual occupational limit of 5 rems. Studies have also shown that the maximum dose rate outside the tank approaches 0.0003 rem/hr at the front of a HA turret or over a fully loaded bustle. Continuous exposure at that level would produce an annual dose of about 2.6 rems or slightly more than one-half the occupational limit. Fortunately, these exposure scenarios represent very unlikely situations. Actual exposures based on realistic times spent in the tanks are likely to be less than 0.1 rems in a year.



Figure 5 - M1A1s in the Gulf

Another external radiation hazard from DU is from contact with the bare skin. DU produces a dose rate of 0.2 rem/hour when it is located in contact with bare skin. The current dose limit for skin (50 rems in a year) would only be exceeded if unshielded DU remains in direct contact with the skin for more than 250 hours. Some reports have mistakenly applied the total effective dose equivalent (whole body dose) criteria of 0.1 rem/year for individual members of the public to this exposure. This leads to the erroneous conclusion that the exposure from one exposed DU penetrator could subject an individual to a dose of radiation thousands of times higher than the recommended maximum permissible dose. The correct criteria is the NRC's occupational dose limit of a shallow-dose equivalent of 50 rems/year to the skin or to each of the extremities.

In fires and during impact, DU forms both soluble and insoluble oxides. The inhalation of the insoluble oxides presents an internal hazard from radiation if they are retained in the lungs. Sustained exposure to the alpha and beta radiation from the material could damage lung tissue. As indicated in the following assessment section, the worst exposures in the Gulf were less than

<sup>21</sup> The figure of 0.00003 rem/hr is obtained when the average annual background dose (.3 rem) is divided by 8,760 hours in a year.

<sup>22</sup> Memo for Record (98-3), Subject: Radiation Measurements on M1A2 With Depleted Uranium, Aberdeen Test Center, 11 December 1997.

one-fifth the annual occupational limit and well below the level known to cause health effects in people.

### **III. ASSESSMENT OF POTENTIAL HEALTH EFFECTS FROM DU IN THE GULF THEATER, 1990-1991**

For DU which enters the body, initial estimates of the radiation dose were derived from "worst case," computer-modeled scenarios in which an Abrams "Heavy Armor" model was struck and its DU armor panels penetrated by a 120mm DU round. The results of one round were doubled to represent the number of penetrations that posed a "worst case" exposure in the Gulf (several M1A1s were hit twice by DU rounds, but no penetrations of their DU armor occurred). Such a "DU-on-DU" penetration would produce levels of DU aerosolization and spalling (spattering of liquified metal) exceeding those that actually occurred during the Gulf War, and therefore result in higher estimates of crew intakes of DU than occurred.

Soldiers involved in such a hypothetical scenario, and who did not retain any DU fragments, would receive an effective dose equivalent of approximately 0.96 rem (See Section III.B.1.c). This radiation dose is less than one-fifth the annual occupational limit, and is well below the level known to cause adverse health effects in people.

Health effects assessments for 13 identified exposure events (shown in Table 1) are being prepared that describe the activities of the participants, specify the sources of potential DU exposure, and estimate the dose from inhalation, ingestion and wound contamination, as appropriate for each exposure category. These assessments also review the current understanding of health effects associated with DU, and provide descriptions of the health risks in plain language. Most of those studies are currently in progress and will be published in about one year. In the meantime, the circumstances of some of the more significant exposure incidents are described (Tab G) so veterans involved in these activities will be able to recognize and understand events that may have exposed them to DU. The veterans can then obtain information about possible health effects, and be advised as to what medical services are available to them.

#### **A. Overview of Participants in Exposure Scenarios**

As Table 1 shows, Gulf War personnel were exposed to DU in a number of ways. Some US combat vehicles were mistakenly destroyed or damaged by US tanks using DU sabot rounds. Personnel worked inside US vehicles contaminated with DU fragments and particles. Several accidental tank fires and an ammunition explosion and fire at Camp Doha, Kuwait in July 1991, resulted in DU rounds being burned, oxidized, or fragmented, which created potential exposure hazards to troops operating in the vicinity. Other troops entered Iraqi armor disabled by DU. Determining the medical consequences of these exposures, if any, requires a systematic, scientifically sound evaluation.

The first step in assessing the health risks from DU was to identify the potential exposures that took place, and then determine the essential facts of each event. This required an aggressive, thorough, and focused investigation that relied on hundreds of eyewitness interviews and thousands of pages of official and unofficial documents, records, reports, memos, and personal diaries and photographs. Information developed during this process was analyzed and synthesized to produce a detailed picture of events of concern.

The exposure scenarios observed during ODS/DS and in months following, were categorized into three levels based on the activities of the soldiers involved, and the resulting potential for direct contact with DU. These three exposure levels provided a prioritized approach to describing and evaluating the potential exposures that occurred:

Level I - Soldiers in or near combat vehicles at the time these vehicles were struck by DU penetrators, or who entered vehicles immediately after they were struck by DU munitions. These soldiers could have been struck by DU fragments, inhaled DU aerosols, ingested DU residues, or had DU particles land on open wounds, burns, or other breaks in their skin.

Level II - Soldiers and a small number of DoD civilian employees who worked in and around vehicles containing DU fragments and particles (mostly friendly fire wrecks). These soldiers may have inhaled DU residues stirred up (resuspended) during their activities on or inside the vehicles, transferred DU from hand to mouth, thus ingesting it, or spread contamination on their clothing. Soldiers who were involved in cleaning up DU residues remaining on Camp Doha's North Compound after the July 11, 1991, explosion and fires are also included in this group.

Level III - An "all others" group whose exposures were largely incidental and very brief. This group includes individuals who entered DU-contaminated Iraqi equipment, troops downwind from burning Iraqi or US equipment struck by DU rounds, or personnel downwind from burning DU ammunition, such as occurred at Doha during the July 11 fire. While these individuals could have inhaled airborne DU particles, the possibility of receiving an intake high enough to cause health effects is extremely remote.

To date, 13 categories of possible DU exposure have been identified and classified within the three levels as shown in Table 1 on page 8.

Substantial research has been conducted to determine the detailed exposure scenarios for participants in the 13 categories; and to perform assessments of the dose and health risk using a quantitative risk assessment process. The activities of many of the Level I, II, and III participants have been reviewed to develop the exposure scenarios. The US Army's Center for Health Promotion and Preventive Medicine (CHPPM) has reviewed existing test data on DU exposures and releases, and is developing dose estimates (chemical and radiological) for Level I exposures. Level I exposures are being addressed first, because these veterans probably received the highest exposures. Results of preliminary dose and risk assessments are reported below.

## B. Level I Exposures (Friendly Fire)

Eight friendly fire incidents involving US M1A1s destroying or damaging occupied US-crewed vehicles with DU munitions occurred during the Gulf War. These incidents (distinct from non-DU friendly fire incidents or cases where friendly vehicles were evacuated and then deliberately destroyed to prevent their capture) resulted in the contamination of six M1/M1A1 tanks and 15 Bradley Fighting Vehicles. Another M1A1 was hit by a large shaped-charge round, believed to be a Hellfire missile fired from an Apache helicopter, that ignited an on-board fire. This incident is described in the "Tank Fires" Section (Tab J). Darkness and low visibility caused by heavy rains, sandstorms, etc., were major contributing factors in all of these incidents.<sup>23</sup>

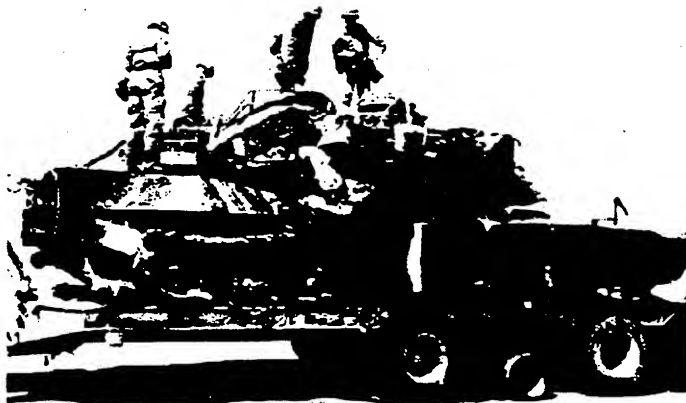


Figure 6 - M1A1 lost to friendly fire

In most cases, owing to battlefield confusion, soldiers manning the targeted vehicles initially believed that the Iraqis had fired the shots that penetrated their armor. The distinctive radioactive trace that DU leaves on the entrance and exit holes allowed a team of battle damage assessment experts to determine (after the fact) which vehicles had been hit by DU sabot rounds fired from Abrams tanks. After-action investigations and word-of-mouth reporting among the units involved generally resulted in the affected soldiers learning that they had been victims of friendly fire. Not all of these soldiers, however, were aware of the potential health effects associated with DU. Therefore, the investigation into the exposures resulting from friendly fire incidents is being accompanied by an effort to identify, locate, and contact all surviving soldiers who were in or on vehicles at the time they were penetrated by DU rounds.

As the spear-point of the ground campaign, US armored crews were often forced to make very rapid "friend or foe" decisions, where failure to engage could allow enemy gunners to take a first, fatal shot. Inevitably, given the swirling meeting engagements and close-in fights that erupted between friendly and enemy units, tragic misidentifications occurred.<sup>24</sup> A total of 21 US combat vehicles (6 Abrams tanks and 15 Bradley Fighting Vehicles) were struck by 120mm DU sabot rounds fired from US M1A1 tanks. Some of these vehicles were struck once, others several times. Based on typical manning configurations for the Abrams tanks (four crew members) and Bradleys (five to nine crew members depending on configuration), as well as

<sup>23</sup> "Military Probes Friendly Fire Incidents" Washington, DC: Office of the Assistant Secretary of Defense, Public Affairs: News Release, August 13, 1991.

<sup>24</sup> For an in depth discussion of how fratricide can occur in ground combat, see: *Applying the National Training Center Experience—Incidence of Ground-to-Ground Fratricide, N-2438-A*, by Martin Goldsmith, The RAND Corporation, February 1986

information gathered from veterans, an estimated 113 soldiers were on board these combat vehicles at the time they were struck by DU penetrators. Table 3 lists the individual systems struck by DU and their estimated manning (see Tab H for a description of each friendly fire incident). Reports have suggested that at least one vehicle was struck initially by enemy fire, evacuated, and subsequently struck by a DU round. If these reports are verified, the numbers reported in Table 3 may decrease.

Table 3 - Summary of US vehicles hit by DU tank rounds

Army Unit	Vehicle Type	Bumper Numbers	Estimated Soldiers Onboard
4-7 Cavalry	Bradley	A-24, A-31, & A-22	15
1-37 Armor	Abrams	C-12	4
1-41 Infantry	Bradley	B-21, B-26, B-33, D-21 & D-26	30
3-66 Armor	Abrams	B-66, B-22, A-14, A-31 & A-33	20
3-15 Infantry	Bradley	C-11, C-22 & C-23	25
4-66 Armor	Bradley	HQ-55 & HQ-54	9
1-34 Infantry	Bradley	HQ-232	5
2-2 Cavalry	Bradley	G-14	5
		Total	113

Level I soldiers, injured or not, were in or around combat vehicles at the time they were struck by DU sabots, or immediately afterward. Besides the embedded fragments from wounds, these individuals may have inhaled DU aerosols generated by fires or by the impact of the DU projectile penetrating the target. The friendly fire incident summaries in Tab H describe the circumstances under which Level I soldiers were mistakenly targeted by US tank crews.

## 1. Soldiers in Vehicle On Impact

### a) Summary of Activities

Armor crewmen and the "dismount" infantry transported in M2/M3 Bradley Armored Fighting Vehicles supplied the offensive striking power for Operation Desert Storm. US armored and mechanized infantry units counted on the speed, mobility, and firepower of their Abrams and Bradleys to maintain a rapid rate of advance while engaging and neutralizing enemy formations standing between Coalition troops and their objectives.

### b) Hazard Identification

Table 4 shows possible combinations of personnel location, form of contamination, and route of exposure for Level I vehicle occupants. Additional details of the scenarios and assessments will be contained in the CHPPM exposure and health risk assessment report when published. Occupants of the vehicles were subjected to wounds from flying fragments, inhalation of

airborne soluble and insoluble DU, ingestion of soluble and insoluble DU residues by hand-to-mouth transfer, and contamination of wounds by contact with contaminated clothing and vehicle interiors.

Table 4 - Potential Hazards to Occupants of Struck Vehicles.

<u>Location</u>	<u>DU Form</u>	<u>Route of Exposure</u>
Inside or Outside the Vehicle	Metal Fragment oxides	Wound Inhalation Ingestion Wound Contamination

Depleted uranium strikes on the exterior of an Abrams differ from those on Bradleys. The Abrams's thicker armor—reinforced at the turret and flanks by DU panels inserted between regular steel armor—offers much greater resistance to the impacting DU round than does the thinner, lighter weight aluminum-alloy skin of the Bradley. This results in a commensurate increase in DU aerosolization and fragmentation created at the point of penetration (and exit) and in the interior of the tank. The Bradley, in contrast, is less vulnerable to interior contamination because DU penetrators typically performed a “through-and-through” penetration of the Bradley's relatively thin armor, forming little aerosolization. During one incident, two DU rounds penetrated and flew through one Bradley and struck a second BFV standing twenty feet away. The range of likely exposures from a DU strike, therefore, can span a broad spectrum. Each incident needs to be carefully analyzed to draw any inferences about an individual's potential exposure. To develop data for an upper bound (worst-case) exposure which could result in the highest levels of contamination, the US Army Center for Health Promotion and Preventive Medicine (CHPPM) calculated the results from a DU sabot round penetrating the DU-protected portion of an Abrams. It should be noted that no such “DU on DU” penetrations occurred during the Gulf War. In several cases, however, Abrams tanks were hit more than once by DU rounds that penetrated non-DU portions of their armor. For this reason, the results from CHPPM's assessment of a single DU round penetrating an Abram's DU armor were doubled.



Figure 7 - Bradley Fighting Vehicle

#### c) Assessment of Health Effects

Soldiers in or on vehicles struck by DU munitions were possibly exposed through four routes: direct wounding, inhalation, ingestion, and contamination of wounds. Wounded soldiers who retained fragments of DU are among the 33 veterans currently being evaluated in the DU Follow-up Program (described in Section IV.C). Additional details of this assessment are discussed in Tab N.

To estimate the intake, the amount of DU taken into the body by inhalation, ingestion, and wound contamination must be established. CHPPM considered available test data from fires and DU impacts with tanks and other combat vehicles. In addition, computer-modeling results were used to show the effects of a DU round penetrating DU armor. Since several M1A1s were struck by more than one DU round during the Gulf war, the results for a single DU round striking DU armor were established, then doubled to provide a high bound or "worst case" estimate. As noted, this "worst case" estimate exceeds known exposures in the Gulf, since no penetrations of DU armor by DU rounds occurred during the Gulf War. In addition, most of the combat vehicles struck by friendly fire DU rounds were Bradleys. DU penetrations of Bradleys produce much less aerosol, since the Bradley's relatively thin aluminum alloy armor offers significantly less resistance to a DU sabot than the Abrams' thicker steel and DU armor. Therefore, the data for single and multiple penetrations of an Abrams Heavy Armor tank considerably overstates the likely exposures for occupants of lightly armored vehicles, i.e. Bradleys.

The preliminary results of the computer-modeling analysis of these inhalation scenarios show a total inhalation intake of DU oxide from two DU penetrations of the tank's crew compartment to be 52 milligrams (mg) maximum and 24 mg average. These intakes were converted to radiation doses of 0.96 rem maximum, and 0.46 rem average using the Lung Dose Evaluation Program (LUDEP), a lung dosimetry modeling program accepted by the ICRP.

The maximum radiation dose for Level I individuals is estimated to be 0.96 rem from two DU penetrators. For comparison, the average radiation dose to a member of the US population from background radiation is 0.3 rem per year.<sup>25</sup> In other words, this maximum estimated exposure of 0.96 rem, that clearly overestimates the likely doses in Gulf War participants, is about the same as living in the United States for about three years<sup>26</sup> and is less than one-fifth the annual dose limit for workers of 5 rems.

The chemical exposure based on the same dose scenario described above also assumes a 52 mg intake of DU particles for a 15 minute exposure. The 52 mg intake contains about 9 mg of soluble DU based on test data, indicating that up to about 17% of the airborne DU produced from impacts is soluble (ICRP Class D). For individuals who were in the vehicle when the DU penetrator did not enter the crew compartment, intakes of soluble DU are calculated to be much less, in the microgram range (14 µg).<sup>27</sup>

The estimates of DU intake and resulting radiation dose were used because test data (although limited) on DU concentrations in the air and on surfaces inside an Abrams tank were available to

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<sup>25</sup> Exposure of the Population of the United States and Canada from Natural Background Radiation, Report No. 94, NCRP (National Council on Radiation Protection and Measurements), Bethesda, MD, 1987.

<sup>26</sup> The earlier estimate (one year) reported in the Special Assistant's March 23, 1998 speech to the American Legion was revised upward to represent exposure from two rounds penetrating the turret and to reflect a much lower solubility than was previously used.

<sup>27</sup> Memorandum for the Office of the Special Assistant Secretary for Gulf War Illnesses, Subject: Program Summary, USACHPPM Assistance with OSAGWT's Depleted Uranium (DU) Environmental Investigation Report, August 3, 1998.

support the analysis. Although considerable data gaps prevent a better analysis now, studies to fill those gaps are expected to be available to support analyses in the final version of this report. In addition, this modeling is undergoing scientific peer review before the report is finalized. Nonetheless, the radiation dose estimated here is less than one-fifth the annual limit for workers. A comparison of the estimated health risks from radiation with the possible chemical toxicity effects of soluble uranium oxides demonstrates that DU's heavy metal toxicity effects may be the primary concern.

## **2. Soldiers Entering Vehicles Immediately After Impact**

### **a) Summary of Activities:**

Friendly fire incidents were usually witnessed by other US soldiers who in most cases served in the same platoon or company as the personnel in the struck combat vehicle. Typically these troops would rush to the aid of the stricken vehicle's occupants to perform emergency first aid and rescue operations. The responding troops often entered damaged or destroyed vehicles moments after they had been hit, raising concerns that they may have been exposed to DU residues or oxides still airborne from impacts, or stirred up by the activities of survivors and rescuers inside and outside the vehicles.

### **b) Hazard Identification**

The activities outlined above for people who entered immediately after impact indicate that members of this group were potentially exposed in three ways. Personnel outside the tank could be subject to DU through ingestion of DU by hand-to-mouth transfer of contamination from the outer surfaces of the vehicle. Troops who enter the struck vehicles could inhale DU aerosols from the initial impact or resuspended (stirred up) DU residues. They could also ingest DU through hand-to-mouth transfer, or have DU settle in breaks in their skin (burns, wounds, or scratches).

### **c) Assessment of Health Effects**

The full assessment of exposure details, dose, and risk for this group requires additional work to fill data gaps on resuspension of DU, transfer from hand to mouth, and wound contamination. CHPPM is continuing to research these cases, and has identified needs for additional information from the affected veterans. Initial assessments indicate that these individuals are very likely to have received smaller exposures than those who were in the vehicles when struck.

## **C. Level II Exposures**

Once the crews and other injured personnel had been evacuated from the scene, Explosive Ordnance Disposal (EOD) teams, Battle Damage Assessment Teams (BDAT), Radiation Control (RADCON) teams and salvage and/or maintenance personnel converged on the damaged equipment. They removed munitions, personal weapons, and sensitive or salvageable



equipment, surveyed the damage and surrounding area, and prepared the damaged vehicles for transport to a salvage depot in Saudi Arabia. At the salvage depot, troops from the 144<sup>th</sup> Service and Supply Company, unaware of the potential DU hazard, often worked inside the wrecked vehicles to salvage them or prepare them for destruction and/or burial.

In addition to six Abrams and 15 Bradleys knocked out in friendly fire incidents, several other tanks were damaged or destroyed by accidental non-combat fires (see Tab J for an accounting of vehicles sustaining accidental fires). These vehicles were contaminated by "cook-offs" of their on-board DU ammunition (typically 37 rounds per tank). As such, they required essentially the same decontamination as vehicles lost to friendly fire.

EOD and RADCON personnel also played key roles in responding to the post-war (July 11, 1991) Camp Doha motor pool fire in which three M1A1 tanks uploaded with M829 DU sabot rounds were destroyed, as well as several hundred DU rounds stored nearby. Clean-up efforts in Camp Doha's motor pool area (the North Compound) also exposed several hundred troops to residual DU contamination in the vicinity of the burned tanks and ammunition conexes (see Tab I for a description of the Doha fire and cleanup). EOD personnel also entered DU-contaminated enemy combat vehicles with greater frequency and duration than other troops. These activities exposed the troops involved to contact with "resuspended" (stirred-up) DU particles, oxides, and residues, albeit at a much lower level than the Level 1 cases. These exposures could take the form of inhalation and/or ingestion of DU (especially during hand-to-mouth transfer). A more complete discussion of Level II activities and practices can be found at Tab G.

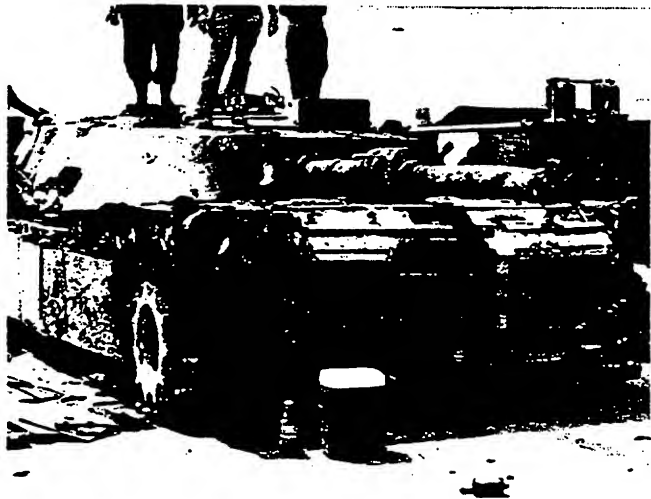


Figure 8 – RADCON personnel atop M1A1 hulk.

#### **D. Level III Exposures**

This category includes individuals who incurred relatively fleeting exposures from climbing on or entering DU-exposed US or Iraqi combat vehicles to remove equipment or "trophy hunt" for souvenirs. It also includes personnel exposed to the smoke from burning tanks containing DU rounds. Several such incidents occurred during and after the War; the most notable being the Camp Doha, Kuwait, motor pool fire. In addition to personnel who are included in the Level II category—involved in cleaning up the North Compound—hundreds of additional troops may have received short-term exposure to the smoke from burning DU munitions stored in tanks or conexes. It is probable that some DU particles were entrained in the smoke that drifted over the

soldiers who had evacuated to the southern tip of the base. A more complete discussion of Level III activities and practices can be found at Tab G.

### **E. Other Activities Under Investigation But Not Yet Categorized**

The Office of the Special Assistant is often contacted by veterans who wish to report incidents that they believe could have exposed them to DU contamination. The incidents they describe are often isolated or unique events for which the available information is largely anecdotal. Each of these reports is investigated; in the following cases, however the Office of the Special Assistant cannot conclusively state, based on the available evidence, that DU exposures did or did not take place. Hence, they remain under investigation and have not been categorized. A more detailed description of these accounts is contained in Tab G after Level III Exposures.

#### **1. Welders**

Several veterans have reported welding DU armor panels onto the frontal turret armor of M1A1 tanks during refit operations to bring the tanks up to a higher survivability standard. Program managers, a senior metallurgist, and other personnel involved in the M1 refit program have disputed these claims, saying the panels in question were regular steel armor. Although this allegation remains under investigation, the initial assessment is that DU was not involved.

#### **2. Reported Ammo Truck Explosion**

A veteran reported seeing a US ammunition truck explode in the area of the 1<sup>st</sup> Infantry Division on the third or fourth day of the ground war. According to the veteran, a mixed load of high explosive and DU rounds exploded. Other soldiers and officers recalled an incident where a truckload of 155mm rounds or charges exploded after the truck's brakes caught fire and its driver (who apparently escaped injury), drove the truck into the desert to reduce the hazard to other soldiers. Although the available evidence suggests that DU rounds were not involved, information regarding this incident is still being sought.

#### **3. Airmen Responding to A-10 Crash**

An A-10 aircraft crashed and burned while trying to recover at King Khalid Military City (KKMC) in northern Saudi Arabia. The crash could have exposed emergency response personnel (firefighters, security policemen, rescue personnel) to smoke and DU oxides from burning 30mm DU rounds uploaded on the A-10. In addition, clean-up crews might have been exposed to DU fragments, residues, and oxides. This case is under investigation.

#### **4. "Hot gun" response for A-10 Aircraft**

30mm DU rounds sometimes misfired in the A-10's GAU-8 cannon. These "hangfires" would have to be cleared and removed from the gun barrel, potentially exposing ground crews to airborne DU. These incidents are still being identified and investigated by this office.

## IV. FOLLOW-UP

Although DoD had conducted extensive research into environmental and medical concerns associated with the various DU munitions, several data gaps were identified during the Gulf War that necessitated further investigation. This section addresses environmental assessments of DU contamination on the battlefield, recent environmental studies of various DU munitions, results of current medical studies, future monitoring efforts, and on-going and planned research.

### A. Environmental Assessments

Since Desert Shield/Desert Storm, the US Army Center for Health Promotion and Preventive Medicine (CHPPM) has conducted limited environmental sampling in the Gulf Region. Using radiation levels as a marker for the presence of DU or its compounds, i.e. DU oxides, a 16-member medical team deployed to Saudi Arabia, Kuwait, and Bahrain from October 19, 1994 to December 3, 1994, in part to evaluate potential occupational and environmental hazards to personnel deployed to the region. Potential exposures to DU were only one of the environmental concerns evaluated.

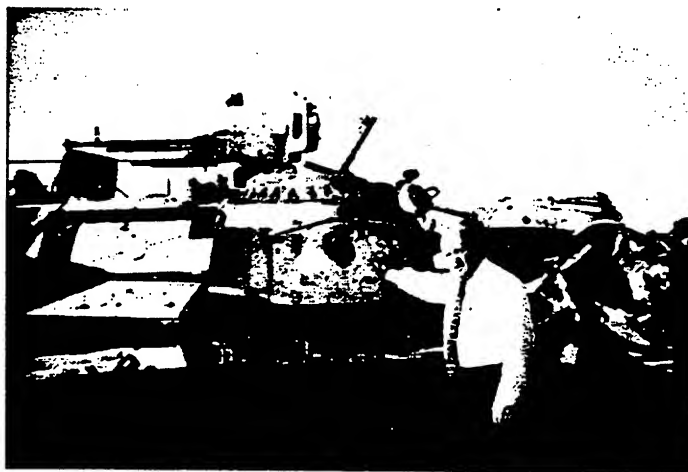


Figure 9 – Dr. Rostker (Special Assistant for Gulf War Illnesses) at Kuwait's "Valley of Death" Boneyard.

The team performed a screening survey for DU exposures at the "Valley of Death Boneyard" at the Udairi Range. This is the area used to store many of the vehicles destroyed by DU munitions during the Gulf War. The team collected a series of samples to evaluate the radiological hazard associated with the boneyard. The team selected vehicles, which had been hit by DU rounds, as confirmed by radioactivity levels at the penetration holes. Wipe samples were taken near the penetration holes to determine if the contamination was "fixed," as in molten spatters that had reformed and hardened around entrance or exit holes, or removable, i.e. oxides or residues that could be swept away. The report concluded that the remaining contamination was fixed. The team collected soil samples in drainage pathways on the site, and used lapel-mounted "personal breathing zone" samplers to assess personnel exposures at the site. The report concluded that:

(N)o measurements significantly exceeded any applicable regulatory or consensus radiation protection exposure limit values used for assessing radiological health risk. In addition, these results indicate no DU exposure hazard to military personnel

working outside the boneyard but still within its immediate vicinity as long as there are no ongoing operations within the boneyard.<sup>28</sup>

CHPPM also conducted radiological analysis of 215 air samples collected during the 1991 Kuwaiti Oil Well Fires study at various military facilities throughout Kuwait and Saudi Arabia.<sup>29</sup> The report stated that "(A)ny dose assessments calculated using the measured radionuclide concentrations from air filter samples are well below US regulatory limits for the general public."<sup>30</sup>

In an effort to further evaluate environmental conditions encountered by US troops in Kuwait and Saudi Arabia, the US Army Central Command deployed the 520<sup>th</sup> Theater Army Medical Laboratory to Camp Doha in early March 1998, to supplement the already deployed Theater Medical Surveillance Team. These personnel conducted environmental surveillance during the Spring and early Summer. If available, the results of any DU investigations that they undertake will be incorporated in the next update of this DU Environmental Exposure Report.

In addition, there has been independent research concerning environmental testing for ambient exposures to uranium in the Gulf War Region. A study by Firyal Bou-Rabee, a professor in the Department of Geology at Kuwait University, reported on sampling performed on air, tap water, and soil samples at various locations in Kuwait. The report stated that the uranium in tap water was very low, which he attributes to the fact that their tap water is produced from desalinated seawater. Although the report did not specify where the ambient air sampling was conducted, the report concluded, "these uranium concentrations in the surface air do not represent any substantial radiological hazard for the Kuwait population." The total annual intake of uranium by inhalation in Kuwait was reported to be less than 0.2% of the recommended annual limit on intake for members of the general population.<sup>31</sup>

## **B. Developmental Testing and Evaluation of DU Munitions – Post Gulf War**

The M919 25mm APFSDS-T cartridge that entered service in 1995 for use in Bradley fighting vehicles is the only new DU munition to be fielded by the US since the Gulf War. The results of the environmental sampling conducted during the hazard classification testing on the M919 were consistent with hazard classification testing performed on other DU munitions with certain

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<sup>28</sup> Problem Definition and Assessment (PDA) Team Activities During Operation Vigilant Warrior - 94, Final Report, US Army Medical Research Institute of Infectious Diseases, May 8, 1995, p. 20.

<sup>29</sup> Kuwait Oil Fire Health Risk Assessment No. 39-26-L192-91, Final Report, 5 May - 3 December 1991, Appendix H, Radiological Analysis, February 1994, p. H-2, H-6, H-7 and Enclosure 2.

<sup>30</sup> Kuwait Oil Fire Health Risk Assessment No. 39-26-L192-91, Final Report, 5 May - 3 December 1991, Appendix H, Radiological Analysis, February 1994, p. H-6

<sup>31</sup> Firyal Bou-Rabee, Estimating the Concentration of Uranium in Some Environmental Samples in Kuwait After the 1991 Gulf War, Applied Radiation Isotopes, Volume 46, Number 4, p 217-220, 1995, Elsevier Science LTD, Great Britain.

caveats (see Tab E).<sup>32</sup> The report concluded, "no measurable DU became airborne as a result of the External Fire Stack Test."<sup>33</sup> During hard impact testing, less than 10% of the DU was aerosolized and less than 0.1% of the initial mass of the penetrator was in the respirable range. Eighty-three percent (83%) of the oxide formed was insoluble.<sup>34</sup>

In order to evaluate real-life hazards of a fire involving a fully loaded Bradley Fighting Vehicle (BFV), the Army also conducted a burn test of a BFV equipped with TOW anti-tank missiles and 1,125 M919 25mm cartridges in 1994. The BFV was completely engulfed by the fire and burned vigorously for about an hour. The fire subsided after an hour, but continued to emit a plume over the next five hours with smoldering hot spots into the next day.<sup>35</sup> Of the 1,125 DU penetrators, 625 were accounted for, including nine live rounds found within a few meters of the test pad. Although 500 rounds were unaccounted for, the report indicated that a large percentage was trapped within the melted remains and a significant amount of the DU oxide was mixed within the ash and settled inside and around the hull of the vehicle. Although a small amount of DU oxide was released during the fire and subsequent explosions, only trace amounts were detected on the air monitoring filters placed at various distances from the Bradley during the 29 hours of air sampling.<sup>36</sup> The major difference between the Bradley Burn test and previous stack test burns was that six readily accessible piles of DU oxide were discovered in the burned out remains of the BFV. The BFV burn test was the first burn test that actually involved a vehicle fire. Previous burn tests were conducted in conjunction with hazard classification tests and involved metal and wooden storage crates. The results of the BFV fire may be more "life-like" and representative of actual battlefield results than previous hazard classification tests under less realistic conditions. The final report is scheduled to be released in the Fall of 1998.

Depleted uranium hard impact aerosolization testing was conducted in various foreign armored vehicles in June 1995 at the US Army Research Lab Test Facility located at the Department of Energy's Nevada Test Site as a piggyback to a Joint Live Fire Lethality Test of 120/25 mm DU munitions versus Soviet-produced armored vehicles. Both source term and resuspension testing of DU aerosols were conducted. Several technical and procedural difficulties seriously affected the data and limited the conclusions that could be drawn from this testing. In spite of these drawbacks, there were several key findings:

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<sup>32</sup> M.A. Parkhurst, J. Mishima, D.E. Hadlock, and S.J. Jette, Hazard Classification and Airborne Dispersion Characteristics of the 25-MM, APFSDS-T XM919 Cartridge, PNL-7232, Richland, WA: Battelle Pacific Northwest Laboratory, April 1990.

<sup>33</sup> M.A. Parkhurst, J. Mishima, D.E. Hadlock, and S.J. Jette, Hazard Classification and Airborne Dispersion Characteristics of the 25-MM, APFSDS-T XM919 Cartridge, PNL-7232, Richland, WA: Battelle Pacific Northwest Laboratory, April 1990, p. vi.

<sup>34</sup> M.A. Parkhurst, J. Mishima, D.E. Hadlock, and S.J. Jette, Hazard Classification and Airborne Dispersion Characteristics of the 25-MM, APFSDS-T XM919 Cartridge, PNL-7232, Richland, WA: Battelle Pacific Northwest Laboratory, April 1990, p. vi.

<sup>35</sup> M.A. Parkhurst, M.H. Smith, and J. Mishima, Bradley Fighting Vehicle Burn Test. Final Draft Report, Richland, WA: Battelle Pacific Northwest Laboratory, October 1997, p. 6.1.

<sup>36</sup> M.A. Parkhurst, M.H. Smith, and J. Mishima, Bradley Fighting Vehicle Burn Test. Final Draft Report, Richland, WA: Battelle Pacific Northwest Laboratory, October 1997, p. 6.1-6.5.

- DU aerosols, containing particles of respirable sizes, are generated inside impacted armored vehicles by DU penetrator impact. The concentration of DU aerosol decreases with time, but measurable concentrations of respirable particles remain suspended hours later.
- Measurable quantities of DU oxide particles can be resuspended during routine personnel re-entry activities, and that the resuspended aerosols contain particles of respirable sizes.<sup>37</sup>

### C. DoD and VA Medical Surveillance Programs for Gulf War Veterans

In 1993, the Office of the Army Surgeon General reviewed medical records of soldiers who had been hospitalized for wounds sustained in friendly fire incidents in the Gulf War. This review identified 22 soldiers whose records indicated retained metal fragments that might contain DU. Thirteen additional soldiers were identified as having been injured and potentially exposed to DU by friendly fire, but were not specifically identified as having metal fragments. Since 1993, the Baltimore Veterans Affairs (VA) Medical Center DU Follow-up Program has followed thirty-three of these individuals who were manning US Army vehicles at the time they were struck by DU munitions.

The 33 individuals evaluated at the Baltimore VAMC in 1993 and 1994 underwent a comprehensive medical and psychological evaluation. They also underwent a full-body x-ray survey, looking for retained metallic fragments. While these veterans have very definite medical afflictions resulting from their wartime injuries, they are not sick from the heavy metal or radiological toxicity of DU. Some veterans have multiple tiny fragments of DU scattered in their muscles and soft tissues. These fragments cannot be surgically removed without causing extensive damage to the surrounding tissues. Individuals who demonstrated increased excretion of uranium in the urine had evidence of retained DU fragments on X-rays. No detectable adverse effects on the kidneys were observed. No cases of cancer have been diagnosed in these participants; nor would one expect any at this point since the latency period for the onset of cancers possibly related to environmental exposure is at least twenty years. Since the Gulf War, all babies fathered by the veterans in the DU Program were born without observable birth defects.

In 1997, this group of DU-exposed servicemen returned to the Baltimore VA Medical Center for a three-day follow-up evaluation. Again, no detectable adverse effects on the kidneys were observed. Urine uranium excretion was still elevated above normal levels for the individuals retaining embedded DU fragments.

Another VA follow-up program was initiated in 1993 to evaluate the exposures of the 144<sup>th</sup> Service and Supply Company, the Army National Guard unit from New Jersey, which operated

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<sup>37</sup> Depleted Uranium (DU) Hard Impact Aerosolization Test Summary Report (Source Term and Resuspension Estimates), U.S. Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ, January 1998.

the damaged equipment yard at King Khalid Military City. Twenty-seven members of this unit were exposed to DU for a period of several weeks before being informed that some of the equipment in the yard had DU contamination. A cohort of 12 volunteers was medically evaluated at the Boston VA Medical Center in 1992. Eight of these servicemen volunteered to undergo urine testing and whole-body radiation counting, and four others underwent only the whole-body radiation counting. Although these individuals were potentially exposed to DU dust on and off over several weeks, the test results showed no residual body-burdens of DU.<sup>38</sup>

In July, 1998, the Department of Defense (DoD) and the Department of Veterans Affairs (DVA) instituted a medical follow-up program to evaluate veterans who received the largest DU exposures during the Gulf War. The follow-up program is aimed at ensuring that Gulf War veterans with higher-than-normal levels of uranium in their bodies are identified and given appropriate monitoring and treatment. The follow-up will be executed in phases. It is likely that most soldiers will have normal levels of uranium in their bodies. This program will provide reassurance to them. The program requires a 24-hour urine collection for urine uranium level and a detailed DU exposure questionnaire in addition to the examination Gulf War veterans receive through the Comprehensive Clinical Evaluation Program (CCEP) or the Department of Veterans Affairs (VA) Gulf War Registry. The notification and medical evaluation components of the program are described below.

### **1. Identification and Notification of Gulf War Veterans with Potential DU Exposures**

As discussed in Section III and depicted in Table 1, the investigation by the Office of the Special Assistant has classified possible Gulf War DU exposures into 13 separate activities, which are in turn categorized into three levels. This investigation was intended to determine how many US service personnel may have been exposed to DU, to what degree, and the possible health impact of these exposures. Underlying all of the Gulf War illnesses investigations is the responsibility to provide useful information to Gulf War veterans and their health care providers.

Initially, the Office of the Special Assistant's investigators will concentrate on locating the soldiers in Level I. Level I includes approximately 113 soldiers who were in or on top of a vehicle at the time it was penetrated by DU munitions, plus an estimated 30 to 60 more who entered burning DU-contaminated US vehicles to perform rescue operations. This group (especially the ones with retained DU fragments) is considered to have had the highest exposure to DU.

Trained interviewers will contact these 140 to 180 individuals by telephone, for two major purposes. First, the veterans will be informed about the availability of the DoD and VA DU medical screening programs, and they will be encouraged to enroll in the VA or DoD's Comprehensive Clinical Evaluation Program (CCEP) program for which they are eligible. They will be informed that a follow-up letter will be sent within a week of the initial phone contact.

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<sup>38</sup> Facsimile from Department of Veterans Affairs, Medical Center and Outpatient Clinics, Boston, MA: May 14, 1997.

This letter will contain additional information on how to enroll in the medical programs and who to call for further assistance at the Office of the Special Assistant. Copies of the follow-up letter and a fact sheet on DU, as well as more detailed information about the phases of the follow-up program, are presented in Tab K. Thirty-three of the Level I individuals are already being followed by the Baltimore VA.

Second, the Office of the Special Assistant has analyzed friendly fire incidents in order to identify surviving troops who may have been exposed to DU. These veterans will be contacted by the Office of the Special Assistant and asked to provide information about their relevant experiences in order to reconstruct possible DU exposure levels and to establish a fuller accounting of personnel who were in or on the vehicles, or who performed immediate rescue operations.

After the initial emphasis on locating the individuals in Level I, the Office of the Special Assistant will expand its efforts to contact individuals from Level II whose duties required them to make numerous trips into equipment contaminated with DU (an estimated 115 to 183 individuals). This group includes 12 members of the Battle Damage Assessment Team, 6-12 Logistics Assistance Representatives, 27 members of the 144<sup>th</sup> Service and Supply Company, 30-60 unit maintenance personnel who performed maintenance on or in DU-contaminated systems, 30-60 EOD and unit personnel who downloaded equipment and munitions from DU-contaminated equipment, and 10-12 Radiation Control team members.

If after evaluating the groups described above, there is medical justification for looking at lesser exposed groups, the notification and medical follow-up will be extended to groups, such as the estimated 600 soldiers involved with the cleanup of the North Compound of Doha. In any case, veterans who are not among those to be notified and are concerned about their possible DU exposures will be able to obtain a DU medical evaluation from a DoD or VA physician, at the appropriate facility that is closest to them.

Should any health problems be detected, there will be an opportunity for a medical follow-up with a local primary care physician and/or specialists. The staff at the Baltimore VA is available to consult with primary care physicians about how to assess DU exposures clinically, how to interpret the results of tests for urinary uranium, how to educate veterans who have concerns about DU, and other relevant clinical questions.

## **2. DoD and VA Medical Evaluation Program for Gulf War Veterans with Potential DU Exposures**

The DU medical evaluation program consists of three elements:

- the Phase I registry exam, which is currently used by DoD's Comprehensive Clinical Evaluation Program and VA's Gulf War Registry;
- an additional detailed questionnaire, designed to evaluate potential DU exposure; and
- a 24-hour urine collection for uranium level.



The Phase I registry exam includes: several questionnaires on demographics, Gulf War-related exposures, and medical history; a thorough physical examination; routine laboratory tests; and consultations with specialists, if needed. An additional exposure questionnaire will be added, which includes questions on the dates and locations of deployment, specifics about the potential type and duration of DU exposure (i.e., friendly fire vs. inspection of DU-contaminated vehicles), and whether the individual was wounded.

Each individual in the DU surveillance program will be asked to provide a 24-hour urine collection in a special container. Each of these urine specimens will be shipped to the Baltimore VA and analyzed by a single laboratory used for the uranium monitoring. The Baltimore VA will mail the results and their interpretation to the individual veteran, with a copy to the examining physician. Recommendations for follow-up will depend on whether the urinary uranium level is normal or increased.

Based on the ongoing monitoring of the 33 participants in the Baltimore program, the vast majority of individuals who enroll in the DU medical surveillance program are expected to demonstrate normal urinary uranium levels. These individuals should receive education and reassurance through appropriate communication from their primary care physicians.

If an individual demonstrates an elevated urinary uranium level, he or she will be referred to the Baltimore VA for further evaluation. Based on the results of the thirty-three participants in the Baltimore program, a high urinary level is a likely indication of previously unrecognized, retained DU fragments. Any individual showing elevated levels of uranium in their urine will be encouraged to receive follow-up in the Baltimore VA program. This follow-up will include periodic medical exams and urinary uranium determinations.

Based on more than 103,000 exams that have been performed in the CCEP and VA Gulf War Registry, many previously unrecognized or asymptomatic health problems have been detected (e.g. hypertension or diabetes mellitus). Therefore, it is likely that some of the veterans who enroll in the DU medical evaluation program will have health problems unrelated to DU exposure. Using appropriate clinical terms, physicians should carefully explain and interpret these health problems to veterans. Veterans who have chronic health problems should receive follow-up primary care at the appropriate military Medical Treatment Facility or VA Medical Center.

Some Gulf War veterans have expressed concerns about potential DU exposures, which were at much lower levels than those experienced by the veterans involved in the Level I or Level II categories. For example, some veterans are concerned about potential exposures from climbing on board damaged Iraqi vehicles, or from being present in the South Compound during the fire at Doha, in July 1991. While they are considered to have a much lower risk than the veterans in the friendly fire incidents, veterans with these lower exposures may still have questions for their physicians. Veterans in these lower exposure categories will not be specifically identified or contacted by the Office of the Special Assistant, but they may refer themselves to the DoD or

VA for medical advice. If these individuals and/or their physicians believe it is warranted, they will receive a DU medical evaluation. The physicians who perform the CCEP exams and the VA Gulf War Registry exams at each of the Medical Treatment Facilities and VA Medical Centers nationwide have been trained to perform DU medical evaluations. These medical evaluations are modeled on the evaluations developed by the Baltimore VA.

#### **D. Postwar Research**

There are two major, ongoing laboratory investigations of the health effects of DU, at the Armed Forces Radiobiology Research Institute, and at the Lovelace Respiratory Research Institute.

The Armed Forces Radiobiology Research Institute (AFRRI) in Bethesda, Maryland, is currently assessing the toxicity of embedded depleted uranium (DU) in the Sprague-Dawley rat. This research has relevance to Gulf War veterans who have retained DU fragments, which cannot be removed because the surgery would cause significant tissue damage. In previous studies in experimental animals, the major effect of short-term, high doses of uranium was cellular damage in the kidneys.

The goal of the AFRRI study is to evaluate kidney, behavioral, neurological, and reproductive toxicity associated with DU pellets implanted in the muscles of male and female Sprague-Dawley rats. Tissues are also assessed for uranium concentrations and cellular changes. There are two groups of comparison rats, animals implanted with tantalum pellets, a control metal, and animals that do not receive implants. The final evaluations of the animals, at 18 months after implantation, will be completed in 1998.

The uranium pellets appear to be dissolving very slowly over time, leading to high levels of uranium in the kidney, urine, and bone. Despite the high DU levels in the kidney, there is no evidence of kidney toxicity, based on several assays. These results indicate that kidney toxicity may be less of a hazard than anticipated.

These experiments demonstrate that uranium can cross the blood-brain barrier, similar to other heavy metals. Despite this, there is no evidence for behavioral neurotoxicity in male rats. They have been tested with a functional observational battery, and evaluated for passive avoidance and spontaneous locomotor activity.

The potential effects of DU on reproduction have been evaluated with pregnant rats. The female rats with the DU implants did not show any effects on ability to become pregnant or to carry the litter to term. There were no adverse maternal effects of DU, such as effects on maternal pregnancy weight gain or food and water intake. There were no effects of DU on the litters, such as the number of pups per litter, or weight of the pups. There was a correlation between DU

levels in the maternal kidney, placental tissue, and fetal tissue. The possible effects of DU on the development of the offspring are now being investigated.<sup>39</sup>

In another study, the Lovelace Respiratory Research Institute (formerly Inhalation Toxicology Research Institute), Albuquerque, NM, is conducting similar studies on rats implanted with three dose levels of DU munitions alloys. The studies will attempt to assess potential carcinogenicity of the implanted materials as well as to assess various cellular and biophysical/biochemical effects.

## **V. LESSONS LEARNED AND RECOMMENDATIONS**

DU appears destined to play a major role on future battlefields. The Services need to ensure that all personnel who could be deployed into theaters where DU may be used are aware of its potential environmental and occupational hazards. This would include non-combat medical and support personnel who could find themselves treating DU casualties or repairing DU-contaminated vehicles.

### **A. Improvements in Training and Awareness**

In recognition of the unease with which many people view all things radiological, training and education must address DU's radiological and toxicological properties, as well as ways to minimize any possible risk. All military members should be required to attend annual training courses on DU, preferably incorporated into existing annual Nuclear Biological and Chemical (NBC) initial or refresher training courses. Since DU ammunition is now available to other nations, contamination from DU could be widespread on future battlefields. Therefore, the knowledge, expertise, and equipment to prevent or mitigate exposures must be equally widespread.

In addition to education and training, Service guidance must reflect an elementary recognition of DU as a hazardous material and battlefield contaminant. Regulations, checklists, operating instructions, field standard operating procedures, medical emergency and surgical treatment standards, and other guidance must reflect sound, accurate, and current guidance regarding procedures to be followed in a DU environment in keeping with the principle that exposures should be prevented or minimized whenever possible.

The test and evaluation programs that paved the way for the fielding of DU munitions and armor acknowledged the potential for creating battlefield DU contamination. The Department of Defense (DoD) recognized the need to protect troops who might have to operate in such

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<sup>39</sup> Kimberly A. Benson and Terry Pellmar. Neurotoxicity and Reproductive Effects of Embedded Depleted Uranium in the Rat (abstract). Conference on Federally Sponsored Gulf War Veterans' Illnesses Research; Program and Abstract Book, page 51; Washington, DC, June 17-19, 1998.

environments. Unfortunately, most of the guidance issued before and during the war was oriented toward peacetime accidents on US military installations, rather than addressing the very different demands of wartime and contingency operations. A number of memorandums and advisories (described in Tab O) containing simple, field expedient precautions and advice were sent to the theater, but often failed to reach units and troops who had to respond to accidents and events involving DU contamination.

The DoD has acknowledged that pre-war DU awareness training was inadequate. Abrams crewmen received a brief block of training on the peacetime, regulatory requirements for handling DU munitions. More extensive training was provided to Nuclear-Biological-Chemical (NBC) response personnel assigned to most units, as well as EOD, RADCON, and safety personnel.<sup>40</sup> In general, this information was not shared outside these units or agencies. The lack of DU awareness was identified as a deficiency, as evidenced by a May 24, 1991, memorandum from the Armament Munitions and Chemical Command (AMCCOM) to the Training and Doctrine Command (TRADOC) recommending that DU safety training be given to all armor and infantry soldiers and officers who required it.<sup>41</sup>

On September 9, 1997, the Special Assistant for Gulf War Illnesses wrote a memorandum to the Chief of Naval Operations, Chief of Staff of the Air Force, and Commandant of the US Marine Corps directing them to "ensure that all Service personnel who may come in contact with DU, especially on the battlefield, are thoroughly trained in how to handle it." The US Army's Training and Doctrine Command published Training Support Packages (TSPs) for respective training schools in September 1997. It is too early to evaluate the effectiveness of this training.<sup>42</sup>

On January 7, 1998, John J. Hamre, Deputy Secretary of Defense sent a follow-up memorandum to the Service Secretaries requesting that they provide him with an outline of the Services' depleted uranium training program. This program required identification of personnel categories to receive the training, a schedule for full implementation, and plans for periodic retraining.<sup>43</sup> The Services responded in March 1998, outlining their respective plans along with implementation schedules. Although the Services are expanding their DU training efforts, their actions to date have only marginally improved their ability to contend with DU hazards. Full implementation of the various training programs will be underway during the summer of 1998. The Office of the Special Assistant will continue to monitor the status of the Services' DU training efforts.

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<sup>40</sup> Operation Desert Storm - Army Not Adequately Prepared to Deal With Depleted Uranium Contamination, GAO/NSIAD-93-90. Washington, DC: United States General Accounting Office, Report to the Chairman, Subcommittee on Regulation, Business Opportunities, and Energy, Committee on Small Business, House of Representatives, January 1993, p. 34.

<sup>41</sup> Memorandum from AMCCOM to TRADOC, Subject: Depleted Uranium (DU) Contamination, May 24, 1991.

<sup>42</sup> Memorandum for Chief of Naval Operations, Chief of Staff of the Air Force, and Commandant of the US Marine Corps, "Depleted Uranium Ammunition Training," September 9, 1997.

<sup>43</sup> Memorandum for Secretaries of the Military Departments, "Depleted Uranium Training," January 7, 1998.

## **B. Developing Medically and Operationally Appropriate Guidance**

During and after the Gulf War, the primary source of guidance concerning DU accidents was US Army Technical Bulletin (TB) 9-1300-278, "Guidelines for Safe Response to Handling, Storage, and Transportation Accidents Involving Army Tank Munitions or Armor Which Contain Depleted Uranium." This TB was developed for peacetime accidents and not intended for direct application to combat scenarios. It needs to be rewritten to reflect the realities that will be encountered in operational or battlefield situations. TB 9-1300-278 currently emphasizes the use of MOPP 4 personal protective equipment when operating in a DU-contaminated environment. In reality, MOPP 4 is inappropriate given the actual hazard, and creates significant heat stress problems and degrades personal performance and operational efficiency.

This issue has been recognized by the Army, which has taken steps to remedy the situation. A meeting was conducted in April 1998 to discuss organizational roles and responsibilities relative to low level radioactive hazards in operational settings. An Integration Process Team (IPT) was formed to review low-level radiation as well as nuclear, biological, and chemical hazards, and associated environmental issues. At the soldier level, the Army has developed a new training task "Respond to Depleted Uranium /Low-Level Radioactive Materials (DULLRAM) Hazards". All soldiers must receive this training and demonstrate the appropriate knowledge of the hazard and how to respond to it before they are considered combat-ready. This training, due to commence in FY99, should produce a dramatic, sustained improvement in troop awareness of DU. This new training and its anticipated benefits are detailed in Tab O, Guidance for Protecting Troops.

## **C. Timely, Effective Dissemination of Information**

In addition to instilling awareness of DU in troops, leaders, and units, advisories or warning messages issued by agencies such as AMCCOM must be disseminated in a timely, effective manner to the troops and units requiring that information. Specific reporting procedures and points of contact must also be established and institutionalized so that the information "disconnects" that occurred during the Gulf War are not repeated. Currently, agencies such as the Army Safety Office and the Army Medical Command have well-developed channels for issuing alerts and advisories that reach soldiers through the chain of command as well as unofficial channels like Armed Forces Radio. Many of these existing channels could be used to reinforce and expand servicemembers' ability to operate safely in DU-contaminated environments.

## **D. Responsive Support to Tactical Ground Units**

With few exceptions, most tactical ground units lack the requisite resources or training to effectively respond to large-scale incidents or events involving the uncontrolled release of DU. These units are, of necessity, structured, manned, equipped, and trained to execute a wartime mission. It is not reasonable or realistic to force these units to assume primary responsibility for health physics/industrial hygiene requirements, particularly at deployed locations. Instead,

tactical commanders should be able to count on timely, effective support from dedicated radiation control (RADCON) teams and other specialists, as required.

The post-war ammunition explosion at Camp Doha, Kuwait is an instructive object lesson concerning the need for more rapid, responsive health physics/industrial hygiene support for deployed units. In the first week following a fire that damaged or destroyed 660 DU rounds and three M1A1 Heavy Armor tanks, the unit commander and his staff were forced to rely on the unit's integral NBC assets for advice and assistance in dealing with DU contamination. Unfortunately, these NBC assets were trained and equipped to respond to battlefield nuclear contamination, not accidents involving DU. Although they were familiar with DU and could carry out limited surveys and clean-up efforts, their effectiveness in this role was limited. Although RADCON teams were dispatched to Doha, they did not reach the base until a week after the fire—a week during which the unit leadership, with insufficient knowledge about DU or how to respond to DU contamination, sent troops into an area in which DU contamination was present without any personal protective equipment or DU awareness training. In addition, the RADCON teams deployed to Doha were not sent to support the unit or installation, per se, but rather to decontaminate and remove three contaminated M1A1 tanks and any exposed DU penetrators found in the immediate vicinity. The teams had little interface with the Commander and his staff, and left the installation when their mission was complete. Before, during, and after the RADCON teams' arrival, hundreds of soldiers conducted clearing and clean-up operations in an area with localized DU contamination, without being told about the potential hazard from DU or simple, field-expedient ways to prevent or minimize potential exposures. In future deployments, the Commander, his staff, and unit personnel should be supported by a more robust and responsive in-theater health physics/industrial hygiene capability.

#### **E. Clear and Unambiguous Division of Responsibility**

Given the likelihood of future decontamination/recovery scenarios, executive agents need to be clearly identified and the scope of their duties sufficiently delineated to clearly establish responsibility and accountability for all aspects of the radiation control effort. Most fixed facilities such as Air Force bases have designated specialty teams, e.g., disaster preparedness and bioenvironmental engineering teams with well-defined roles of responsibilities. The responsibilities within operational units, as described above, are not as well defined.

#### **F. Collection and Reporting of Survey and Monitoring Results**

Post-exposure assessments are difficult to quantify in the absence of specific data such as radiation readings. Much of the current anxiety surrounding DU might have been allayed if survey and monitoring efforts had been better documented, and medical testing (e.g. 24-hour or spot urines) accomplished as necessary. According to Army Regulation 40-5, "The necessity, frequency, and methodology for performing bioassay procedures will depend on the radionuclide(s), their chemical and physical form, and the amount of material potentially

available for entry into the human body."<sup>44</sup> Memories corroborated by anecdotal evidence are insufficient to provide conclusive answers to troops who may or may not have been exposed to DU. In the future, radiation control and related medical efforts must be documented in sufficient detail to determine who was exposed, and to what degree.

## **G. Equipment**

The AN/PDR-27, AN/PDR-77 and AN/VDR-2 RADIAC instruments were primarily designed for battlefield nuclear exposures and are less than ideal for detecting and measuring the weak emissions given off by DU. Although improved RADIAC equipment has been deployed with US forces in Bosnia, its availability is limited. Radiation detection equipment must be readily available in combat units to expedite the identification of DU-contaminated vehicles.

The Services need to review their current Personal Protective Equipment (PPE) to ensure that personnel are able to operate safely in a DU environment. Current MOPP-4 gear, while affording protection in most chemical, biological, or radiological environments, can cause a rapid degradation in personal performance, especially in desert conditions and is excessive for most situations involving DU. Since DU contamination appears to be more likely than chemical, biological, or nuclear weapons scenarios, the Services should assess their current requirements to determine if supplemental, lightweight respirators and similar DU-suitable protective equipment could be acquired to replace MOPP-4 in the DU remediation (but not NBC protection) role.

In response to the wartime NBC hazard, procedures have been developed to mark contaminated vehicles or to create chemical hazard areas. Similar procedures should be considered for marking DU-contaminated vehicles and areas.

## **H. Medical**

Considerable research was conducted on the environmental and medical implications of DU munitions during their developmental cycles. However limited research was devoted to establishing the medical effects from embedded DU fragments. Postwar efforts to fill this gap have been initiated through AFRRI's research (described earlier in Section IV.D) and the Department of Veterans Affairs' surveillance and follow-up program (the Baltimore DU Program described in Section IV.C). The objective of this follow-up program is to determine whether the current criteria for removal of metal fragments applies to embedded DU fragments. While results to date indicate no requirement to change existing criteria, continued follow-up is required.

Current and future military munitions and equipment development efforts must evaluate all potentially harmful materials (including tungsten and lead) in the full context of operational exposures. While there are ongoing efforts aimed at fratricide prevention, development efforts must recognize fratricide related exposure scenarios as well as the probability of the enemy

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<sup>44</sup> *Preventive Medicine*, Army Regulation 40-5, October 15, 1990, Paragraph 9-6.a.(2)(a), p. 189.

possessing and using potentially harmful materials. It is clear that DU will be used by future adversaries.

Research is needed to develop better estimates of the amount of depleted uranium that may be internalized by personnel entering vehicles after fires involving depleted uranium, or entering vehicles struck by depleted uranium. This information is required to determine and/or validate peacetime standards of practice and to help in establishing standards of practice for all military operations involving these munitions. This research is the foundation upon which technical bulletins and regulations prescribing DU precautions, exposure reporting, and medical monitoring must be based.

Because bio-monitoring of troops immediately after potentially significant exposure to DU (i.e. friendly fire incidents, immediate rescue efforts and working inside DU contaminated vehicles) was not done during the Gulf War, there are no medical data from such exposures for scientific evaluation. While peacetime bio-monitoring programs are in place, standards and guidance for specific bio-monitoring during combat must be developed and implemented. This monitoring must be tailored to the operational setting, recognizing that data collection during combat would be more difficult than in the postwar cleanup phase.

## VI. CONCLUSION

In this report, the Office of the Special Assistant for Gulf War Illnesses has presented a history of depleted uranium development, its use during the Gulf War, and resulting exposures. The investigation examined DU's properties—chemical and radiological—and what the potential health risks of those properties could mean to an exposed individual.

Each of the DU-exposure incidents reported to date was investigated and analyzed in detail. Investigative efforts were aimed at establishing the facts and circumstances surrounding each incident and determining who might have been exposed. This effort is still ongoing, but the investigation has determined the essential facts of the most serious (Level I and II) exposure incidents and scenarios, as well as identifying many of the participants.

The report acknowledges that many American soldiers were exposed to DU through wounds, inhalation, ingestion, or bare skin contact. It also identifies and addresses significant shortcomings in the way US troops were trained to operate in environments where DU contamination was present, and identifies lessons learned that can be applied to future operational deployments. Further, it outlines steps this Office has taken to ensure that DU training and awareness receives proper emphasis from all Service components.

This report notes past inconsistencies between peacetime guidance and wartime practices. It explains why much of the guidance in place at the time of the Gulf War was excessive or disproportionate to the actual exposure hazard. It makes the case that future guidance must be



practical and applicable to battlefield operations where contact with DU, under uncontrolled conditions, can occur over a broad range of environments.

The report outlines the new, expanded medical follow-up program aimed at identifying, evaluating, and providing medical follow-up, if need be, to personnel likely to have incurred the highest DU exposures. Although the focus of the notification effort is on these participants, soldiers who had lesser exposures can also request an evaluation for DU exposure.

In tandem with efforts to identify exposed personnel, efforts were undertaken to assess the possible health risks and medical significance of various exposure groups. Experts in relevant fields were consulted and expert literature was reviewed. The US Army Center for Health Promotion and Preventive Medicine (CHPPM), is currently performing DU dose assessments in an effort to apply refined data (from computer modeling and live-fire test results) to the study of DU's health effects. The RAND Corporation is doing an independent review of medical and scientific literature on known medical and health effects. Although CHPPM and RAND efforts are ongoing, preliminary estimates of worst case exposures do not indicate a significant radiological hazard. The medical significance of the preliminary chemical (heavy metal) estimates in humans is more difficult to determine and may be clarified once the RAND effort is completed.

Since 1993, the Department of Veterans Affairs has been monitoring 33 vets who were seriously injured in friendly fire incidents involving depleted uranium. These veterans are being monitored at the Baltimore VA Medical Center. While these veterans have very definite medical afflictions resulting from their wartime injuries, they are not sick from the heavy metal or radiological toxicity of DU. About half of this group still have depleted uranium metal fragments in their bodies. Those with higher than normal levels of uranium in their urine since monitoring began in 1993 have embedded DU fragments. These veterans are being followed very carefully and a number of different medical tests are being done to determine if the depleted uranium fragments are causing any health problems. The veterans being followed who were in friendly fire incidents but who do not have retained depleted uranium fragments, generally speaking, have not shown higher than normal levels of uranium in their urine.

Previous research has demonstrated that the organ that is most susceptible to damage from high doses of uranium is the kidney. For the 33 veterans in the program, tests for kidney function have all been normal. In addition, the reproductive health of this group appears to be normal in that all babies fathered by these veterans between 1991 and 1997 had no birth defects.

For the broader veteran population, data derived from the DoD's Comprehensive Clinical Evaluation Program that has evaluated tens of thousands of Gulf War veterans might be more applicable. Thus far, very few Gulf War veterans have been diagnosed with types of kidney damage for which depleted uranium would be on the list of possible causative agents. The rates of these diagnoses in this self-selected population (participation in the CCEP is voluntary) are consistent with the rates of similar kidney problems found in the general US population. By definition, those veterans with undiagnosed illnesses have not had any evidence of kidney

damage. Therefore, there is no evidence that Gulf War veterans are experiencing adverse health effects from DU's chemical toxicity.

The report's bottom-line conclusion, based on a comprehensive review of available data and a science-based methodology, is that exposures to DU's heavy metal (chemical) toxicity or low-level radiation are not a cause of the undiagnosed illnesses afflicting some Gulf War veterans.

***This case is still being investigated. As additional information becomes available, it will be incorporated. If you have records, photographs, recollections, or find errors in the details reported, please contact the DoD Persian Gulf Task Force Hot Line at 1-800-472-6719.***

## ***Tab A - List of Acronyms/Glossary***

This tab provides a listing of acronyms found in this report. Additionally, the Glossary section provides definitions for selected technical terms, which are not found in common usage.

### **Acronyms**

ACGIH.....	American Conference of Governmental Industrial Hygienists
ACR.....	Armored Cavalry Regiment
AD.....	Armor Division
AED.....	Aerodynamic Equivalent Diameter
AEPI.....	US Army Environmental Policy Institute
AFRRI.....	Armed Forces Radiobiology Research Institute
AHA.....	Abrams Heavy Armor
ALARA.....	As Low As Reasonably Achievable
AMC.....	Army Materiel Command
AMCCOM.....	Armament Munitions and Chemical Command
ANG.....	Army National Guard
ANSI.....	American National Standards Institute
AP.....	Armor Piercing
APFSDS.....	Armor-Piercing Fin Stabilized Discarding Sabot
APFSDS-T.....	Armor-Piercing Fin Stabilized Discarding Sabot with Tracer
API.....	Armor Piercing Incendiary
ASTM.....	American Society for Testing Materials
AT.....	Anti-tank
BDAT.....	Battle Damage Assessment Team
BEIR.....	Biological Effects of Ionizing Radiation
BFV.....	Bradley Fighting Vehicle (tracked)
BMP.....	Soviet made armored fighting vehicle (tracked)
BTR.....	Soviet made armored personnel carrier (wheeled)
CFR.....	Code of Federal Regulations
CFV.....	Cavalry Fighting Vehicle
CHPPM.....	Center for Health Promotion and Preventive Medicine
CIWS.....	Close-In Weapon System (20mm Air Defense Gun); also called Phalanx
DoD.....	Department of Defense
DU.....	Depleted Uranium
DULLRAM.....	Depleted Uranium /Low-Level Radioactive Materials
EOD.....	Explosive Ordnance Disposal
FASCAM.....	Family of Scatterable Mines
GAO.....	General Accounting Office
HE.....	High Explosive

HEAT.....	High Explosive Antitank
HEI.....	High Explosive Incendiary
IARC.....	International Agency for Research on Cancer
ICRP.....	International Commission on Radiological Protection
ID.....	Infantry Division
IEEE.....	Institute of Electrical and Electronic Engineers
IOC.....	Industrial Operations Command
JTCG/ME.....	Joint Technical Coordinating Group for Munitions Effectiveness
KE.....	Kinetic Energy
KKMC.....	King Khalid Military City, Saudi Arabia
LAR.....	Logistics Assistance Representatives
MOPP.....	Mission Oriented Protective Posture
mrem.....	millirem (one thousandth of a rem)
NAS.....	National Academy of Science
NBC.....	Nuclear, Biological and Chemical
NCRP.....	National Council on Radiation Protection and Measurements
NJANG.....	New Jersey Army National Guard
NRC.....	Nuclear Regulatory Commission
ODS/DS.....	Operation Desert Shield/Desert Storm
OSHA.....	Occupational Safety and Health Administration
PEL.....	Permissible Exposure Limit
PPE.....	Personal Protective Equipment
RADCON.....	Radiation Control
RADIAC.....	Radiation Detection, Identification and Computation
RHS.....	Rolled Homogenous Steel
RPG.....	Rocket Propelled Grenade
RPO.....	Radiation Protection Officer
SWA.....	Southwest Asia
T-72.....	Soviet-made main battle tank
TB.....	Technical Bulletin
TLV®.....	Threshold Limit Value
UXO.....	Unexploded Ordnance
VA.....	Department of Veterans Affairs
WA.....	97.5% tungsten/2.5% binder in tungsten alloy
µm.....	micron (one millionth of a meter)

## Glossary

Absorbed Dose:	The energy imparted by ionizing radiation per unit of mass irradiated material. The units of absorbed dose are the rad and gray (Gy).
Activity:	The number of nuclear transformations occurring in a given quantity of material per unit of time. (see Curie)
ALARA:	Acronym for "as low as reasonably achievable." The Nuclear Regulatory Commission defines ALARA as making every reasonable effort to maintain radiation exposures to as far below the dose limits as is practical considering the state of technology, the economics of improvements in relation to the state of technology, the economics of improvements in relation to the benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and license materials in the public interest.
Alpha Particle ( $\alpha$ ):	A charged particle emitted from the nucleus of an atom having a mass and charge equal in magnitude to a helium nucleus; i.e., two protons and two neutrons with a +2 charge.
Atom:	Smallest particle of an element, which is capable of entering into a chemical reaction.
Atomic Mass:	The mass of a neutral atom of a nuclide, usually expressed in terms of "atomic mass units." The "atomic mass unit" is one-twelfth the mass of one neutral atom of carbon-12; equivalent to $1.6604 \times 10^{-24}$ gm. (Symbol: u).
Atomic Number:	The number of protons in the nucleus of a neutral atom of a nuclide.
Atomic Weight:	The weighted mean of the masses of the neutral atoms of an element expressed in atomic mass units.
Background Radiation:	Radiation arising from radioactive material other than the one directly under consideration. Background radiation due to cosmic rays and natural radioactivity is always present. There may also be background radiation due to the presence of radioactive substances in other parts of the building, in the building material itself, etc.
Beta Particle ( $\beta$ ):	A charged particle emitted from the nucleus of an atom with a mass and charge equal in magnitude to that of an electron.

Carcinogenic:	Capable of producing cancer.
Class:	Also referred to as Lung Class or Inhalation Class. This refers to a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lungs. Materials are classified as D, W, or Y, which apply to a range of clearance half-times. Class D (Days) are cleared in less than 10 days. Class W (Weeks) are cleared between 10 and 100 days and Class Y (Years) are cleared in greater than 100 days. Recent recommendations in International Commission on Radiological Protection Report #66 have replaced classes D, W, and Y with F (fast), M (moderate), and S (slow).
Curie:	The special unit of activity. One curie is the amount of material in which $3.700 \times 10^{10}$ atoms transform per second. (Abbreviated Ci.) Becquerel (Bq) is replacing it. One Bq is equal to $2.7 \times 10^{-11}$ Ci (or 1.0 disintegrations per second). Several fractions of the curie are in common usage: <p style="margin-left: 40px;">Millicurie: One-thousandth of a curie (<math>3.7 \times 10^7</math> disintegrations per second.). Abbreviated mCi.</p> <p style="margin-left: 40px;">Microcurie: One-millionth of a curie (<math>3.7 \times 10^4</math> disintegrations per second.). Abbreviated <math>\mu</math>Ci.</p> <p style="margin-left: 40px;">Picocurie: One millionth of a microcurie (<math>3.7 \times 10^{-2}</math> disintegrations per second or 2.2 disintegrations per minute). Abbreviated pCi.</p>
Disintegration (Nuclear):	A spontaneous nuclear transformation (radioactivity) characterized by the emission of energy and/or mass from the nucleus. When numbers of nuclei are involved, the process is characterized by a definite half-life.
Dose:	A general term denoting the quantity of radiation or energy absorbed.
Dose Equivalent:	The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert.
Dosimeter:	Instrument to detect and measure accumulated radiation exposure. During the Gulf War, two types of dosimeters were used: a pencil-sized ionization chamber with a self-indicating electrometer and a wrist watch dosimeter, which requires a separate reader. The wrist watch dosimeter detects both gamma and neutron radiation and is intended to measure high doses, e.g.,

following tactical employment of nuclear weapons (rather than DU contamination) on the battlefield.

External Dose:	That portion of the dose received from radiation sources outside the body.
Gamma Ray ( $\gamma$ ):	Short wavelength electromagnetic radiation of nuclear origin (range of energy from 10 keV to 9 MeV) emitted from the nucleus. A gamma ray is essentially equivalent to a x-ray. Both are photons of energy—the difference being that gamma rays originate in the nucleus of the atom and x-rays originate in the extranuclear part of the atom, but x-rays are typically of lower energy.
Gray (Gy):	Standard international unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule/kilogram or 100 rads.
Half-life (Biological):	The time required for the body to eliminate one-half of an administered dosage of any substance by regular process of elimination. Approximately the same for both stable and radioactive isotopes of a particular element.
Half-life (Radioactive):	The time required for a radioactive substance to lose 50 percent of its activity by decay. Each radionuclide has a unique half-life.
Internal Dose:	That portion of the dose received from radioactive material taken into the body.
Isotope:	Atoms having the same number of protons in their nuclei, and hence the same atomic number and element, but differing in the number of neutrons, and therefore in the mass number. All isotopes of an element have identical chemical properties. The term should not be used as a synonym for nuclide.
Joule:	The unit of work, equal to one Newton expended along a distance of one meter ( $1J = 1N \times 1m$ ).
Kilo Electron Volt (keV):	One thousand electron volts or $10^3$ volts.
Newton:	The unit of force, which when applied to a one kilogram mass will give it an acceleration of one meter per second per second ( $1N = 1kg \times 1m/s^2$ ).

Nonstochastic  
Effect:

Health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect. Also called a deterministic effect.

Occupational Dose:

The NRC defines occupational dose as the dose received by an individual in a restricted area or in the course of employment in which the individual's assigned duties involve exposure to radiation and/or radioactive material from licensed and unlicensed sources of radiation. Occupational dose does not include dose received from background radiation, from any medical administration the individual has received, from voluntary participation in medical research programs, or as a member of the public.

Oxide:

A binary chemical compound in which oxygen is combined with a metal or nonmetal.

Public Dose:

The NRC defines public dose as the dose received by a member of the public from exposure to radiation and/or radioactive material released by a licensee, or to any other source of radiation under the control of the licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual received, or from voluntary participation in medical research programs.

Rad (radiation  
absorbed dose):

A unit of absorbed dose. One rad is 0.01 Joule absorbed per kilogram of any material. Also defined as 100 ergs per gram. It is being replaced by gray (Gy). One rad equals 0.01 of a gray.

RADIAC  
Equipment

Radiation detection, identification and computation equipment, or equipment that measures radiation.

Radioactive/  
Radioactivity:

The property of the nuclei of certain atoms spontaneously emitting particles or gamma radiation or of emitting x radiation following orbital electron capture or of undergoing spontaneous fission. Atomic nuclei are of two types, stable and unstable. Unstable nuclei are said to be radioactive and eventually are transformed by radioactive decay into the stable nuclei. One or more of the three types of radioactive emissions ( $\alpha$  or  $\beta$  particles or  $\gamma$ -rays) occur during each stage of the decay.



Radioisotope:	Those isotopes of an element, which are radioactive.
Rem (roentgen equivalent man or mammal):	A unit of measure that takes into account the biologic effectiveness of various types of radiation. The rem is numerically equal to the rad multiplied by a Radiation Weighting Factor (formerly a "quality factor"). The Radiation Weighting Factor (RWF) reflects differences in the amount of each type of radiation necessary to produce the same biologic effect. For beta, gamma, and X radiation, RWF is 1.0, making their effect on tissue equivalent. The RWF for alpha particles is 20, indicating its biologic effect is 20 times greater than the effect of beta, gamma, or X radiation. Sievert (Sv) is replacing rem. One Sv is equal to 100 rem.
Roentgen:	The amount of ionization in air caused by X and gamma radiation. One roentgen of exposure will produce about 2 billion ion pairs per cubic centimeter of air. A roentgen is only a measure of the ionization that radiation produces in air. It does not provide exact information about the amount of energy that is actually absorbed by a medium, or about the effects of the radiation on the medium.
Sabot	A lightweight carrier designed to center a projectile of a smaller caliber in the gun barrel. The sabot is normally employed to fire the smaller caliber projectile from a large caliber main gun; it usually is discarded a short distance from the muzzle.
Sievert (Sv):	Standard international unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the radiation weighting factor (1 Sv=100 rems).
Specific Activity:	The activity of the radionuclide per unit mass of that nuclei. See radioactive.
Solubility:	Capability of being dissolved. The amount of a substance that can be dissolved in a given solvent (i.e., lung fluid) under specified conditions.
Stochastic Effect:	Health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.
Tritium:	Isotope of hydrogen with one proton and two neutrons in the nucleus. Beta emitter.

## **Tab B - Units Involved**

### **7<sup>th</sup> Corps**

#### **1<sup>st</sup> Infantry Division**

##### **1<sup>st</sup> Brigade**

**1-34 Infantry**

**2-34 Armor.**

##### **3<sup>rd</sup> Brigade (from 3<sup>rd</sup> Brigade, 2<sup>nd</sup> Armored Division)**

**1-41 Infantry**

**3-66 Armor**

##### **1<sup>st</sup> Armored Division**

##### **1<sup>st</sup> Brigade (3<sup>rd</sup> Brigade, 3<sup>rd</sup> Infantry Division)**

**4-66 Armor**

##### **3<sup>rd</sup> Brigade**

**1-37 Armor**

##### **3<sup>rd</sup> Armored Division**

**4-7 Cavalry**

##### **2<sup>nd</sup> Armored Cavalry Regiment**

**2-2 Cavalry**

### **18<sup>th</sup> Airborne Corps**

#### **24<sup>th</sup> Infantry Division**

##### **2<sup>nd</sup> Brigade**

**3-15 Infantry**

**3-69 Armor**

### **11<sup>th</sup> Armored Cavalry Regiment**

**1-11 Cavalry**

**2-11 Cavalry**

**58<sup>th</sup> Combat Engineer Company**

**54<sup>th</sup> Chemical Troop**

### **146<sup>th</sup> Ordnance Detachment (EOD)**

### **USS Missouri**

## Tab C - Properties and Characteristics of DU

Natural uranium (extracted from uranium ore) is processed to form enriched uranium for nuclear power. Depleted uranium (DU) is the by-product of this uranium enrichment process. Natural uranium is composed of three isotopes, uranium-238 ( $^{238}\text{U}$ ), uranium-235 ( $^{235}\text{U}$ ) and uranium-234 ( $^{234}\text{U}$ ). Although the exact percentages vary slightly, natural uranium typically is composed of approximately 99.28%  $^{238}\text{U}$ , 0.71%  $^{235}\text{U}$ , and 0.0055%  $^{234}\text{U}$  (See Figure 10). Isotopes of an element have essentially the same chemical and physical properties because they have the same number of protons (92) in their atoms. They differ only in the number of neutrons per atom. For example,  $^{234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$  have 142, 143, 146 neutrons in each atom, respectively. It is this variation in the number of neutrons that gives the different isotopes their radiological properties. Isotopes differ in the types of radiation emitted during the nuclear decay process, decay rate, interactions with nuclear particles, and ability to undergo nuclear fission.<sup>45</sup>

The relative radioactivity of isotopes is measured by their specific activity, which is defined as the number of transformations or disintegrations per second per unit of mass. The unit of measurement of specific activity is microcuries per gram with a microcurie equal to  $3.700 \times 10^4$  disintegrations per second. Although by weight  $^{234}\text{U}$  is only 0.005% of the natural uranium, it accounts for 48.9% of the radioactivity of uranium.  $^{235}\text{U}$  and  $^{238}\text{U}$  account for the remaining 2.3% and 48.8% of the radioactivity of uranium, respectively.

To be used as nuclear fuel or weapons grade uranium, natural uranium must be enriched through a process that increases the  $^{235}\text{U}$  content to approximately 3% for power reactor fuel, or over 90% for weapons grade uranium. This decreases the  $^{238}\text{U}$  content to 97% or less than 10%, respectively, leaving "depleted uranium" with approximately 0.2%  $^{235}\text{U}$  and 99.8%  $^{238}\text{U}$ .  $^{234}\text{U}$  is generally ignored because it is present in such small quantities. In the gaseous diffusion process a gaseous compound of uranium and fluorine,  $\text{UF}_6$ , is separated into two fractions – one enriched in  $^{235}\text{U}$  and one depleted in  $^{235}\text{U}$ . The depleted fraction is then chemically transformed into a uranium metal derby. This is the first stage at which the depleted material is in the state necessary for further processing by ammunition manufacturers.

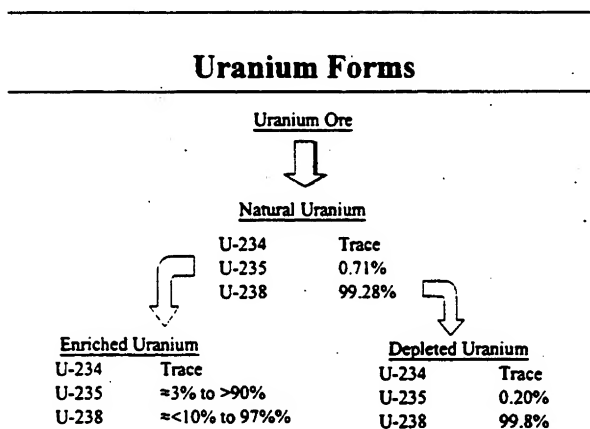


Figure 10 – Content by Mass of Uranium Forms

<sup>45</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report, Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 7-8.

The Nuclear Regulatory Commission (NRC) defines "depleted uranium" as uranium in which the weight percentage of the  $^{235}\text{U}$  isotope is less than 0.711%. Military specifications mandated by the Department of Defense (DoD) require that the percentage of  $^{235}\text{U}$  be less than 0.3%. In actuality, DoD uses DU with a  $^{235}\text{U}$  content of approximately 0.2%.<sup>46</sup> DU is 40% less radioactive than the raw uranium-bearing ores found in nature; but its material content is still uranium. All isotopes of uranium are essentially identical chemically and, since depleted and natural uranium are just different mixtures of the same three isotopes, they have the same chemical properties.

All isotopes of uranium are radioactive. Each has its own unique decay process emitting some form of ionizing radiation: alpha, beta or gamma radiation (or a combination). Alpha and beta radiations are actually discrete particles, whereas gamma radiation is essentially a photon of energy similar to an x-ray but from the nucleus. An alpha particle consists of two protons and two neutrons and is positively charged (+2). Most alpha particles are not energetic enough to penetrate skin and are not considered to be an external hazard. Alpha particles, however, can be a health hazard if inhaled or ingested in sufficient quantities. A beta particle is an electron (charge -1) emitted during the radioactive decay of an atom and is more penetrating than an alpha particle. Beta particles are able to penetrate skin a few millimeters and can pose both an internal and external health risk. Since a gamma ray is a photon of energy with no mass and no charge, it is extremely penetrating, and can be both an internal and external health hazard.<sup>47</sup>

$^{238}\text{U}$ —which by weight makes up almost 99.8% of DU—is an alpha emitter.  $^{238}\text{U}$  has a half-life of  $4.5 \times 10^9$  years.  $^{238}\text{U}$  decays into two short-lived "daughters:" thorium-234 ( $^{234}\text{Th}$ , half-life of 24.1 days) and protactinium-234m ( $^{234\text{m}}\text{Pa}$ , half-life of 1.17 minutes)—which are beta and weak gamma emitters. Because of this constant nuclear decay process, very small amounts of these "daughters" are always present in DU.  $^{235}\text{U}$  (half-life of  $7.0 \times 10^8$  years) decays into protactinium-231 ( $^{231}\text{Pa}$ , half-life of  $3.25 \times 10^4$  years), which is an alpha, beta, and gamma ray emitter.<sup>48</sup> The  $^{238}\text{U}$  and  $^{235}\text{U}$  chains continue through a series of long-lived isotopes before terminating in stable, non-radioactive lead isotopes  $^{206}\text{Pb}$  and  $^{207}\text{Pb}$ , respectively.

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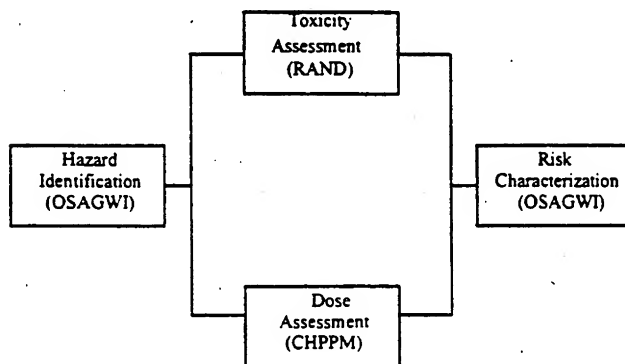
<sup>46</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report, Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 23.

<sup>47</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report, Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 8-9.

<sup>48</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report, Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 12.

## Tab D - Methodology

To estimate the health risks from such exposures, DoD adopted a health risk assessment methodology based on that used by the US Environmental Protection Agency. This process, illustrated in Figure 11, estimates the health risk from contaminant concentrations, site exposure, and contaminant toxicity characteristics. It consists of four steps: Hazard Identification, Dose Assessment, Toxicity Assessment, and Risk Characterization.



Modified from Quantitative Health Risk Assessment Model, National Research Council, "Risk Assessment in the Federal Government: Managing the Process," 1983.

Figure 1.1 - Health Risk Assessment Process

*Hazard Identification* determines who was exposed and how. This includes identification of: a) the possible contaminants (DU); b) individuals exposed to that contaminant; c) exposure pathways (such as inhalation); and d) which incidents need to be evaluated. *Dose Assessment* estimates the intensity, frequency, and duration of exposures to DU and what the chemical and radiological intakes these doses represent. *Toxicity Assessment* involves researching the medical effects of exposure to DU and at what

levels of exposure these effects occurs. *Risk characterization* is the "bottom line" of the health risk methodology. Using both dose-assessment and toxicity assessment data, the risk assessment provides an explanation of the health risk from a given activity or exposure scenario. To arrive at this assessment, the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) developed an investigation and validation process that includes:

- A detailed reconstruction of the conditions and circumstances surrounding the various exposure scenarios.
- Evaluation of available, pertinent environmental factors—e.g., radiological surveys, air quality monitoring, and other data as appropriate.
- Eyewitness testimonies.
- A review of operative policies, guidance, and directives in place at the time of the incidents in question.
- A review of actual practices and compliance with policies, guidance, and directives in force during the events in question, and identifying issues not adequately addressed by that guidance.
- A review of the existing body of scientific and medical data relative to known Gulf War exposure conditions and variables.
- Identification of information gaps and essential elements of information.

- Review of the current body of scientific and medical information on the health effects of DU.
- Preparation of detailed health risk assessments for each of the activities identified with potential DU exposure.

Performing this assessment for DU involves the cooperative efforts of several organizations, specifically;

- The Office of the Special Assistant for Gulf War Illnesses - Hazard Identification and Risk Characterization.
- US Army Center for Health Promotion and Preventive Medicine (USACHPPM) – Exposure and Risk Assessment.
- RAND Corporation - Toxicity Assessment.

## ***Tab E - Development of DU Munitions***

### ***1. Operational Requirements and the Development of DU Munitions***

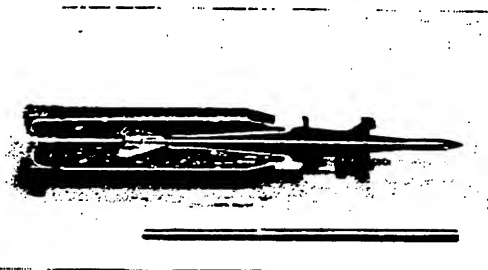


Figure 12 – DU Sabot round with penetrator

During the late 1950s, the primary material used for kinetic energy, armor-piercing projectiles was tungsten carbide. When first fielded, tungsten carbide represented a quantum improvement over its nearest competitor, high carbon steel. Its higher density (approximately 13 gm/cc) gave it superior penetration performance against existing armor targets. With the advent of double and triple plated armor in the 1960s, however, tungsten munitions showed a tendency to

break up before penetrating the layered armor. This deficiency spurred the development of new alloys and materials capable of defeating any armored threats.

In response to the new operational requirements, a succession of metal alloys were evaluated. Initially, the UK Government developed a higher density tungsten alloy consisting of 93 percent tungsten and 7 percent binder tungsten alloy (WA). The new WA alloy had a density of 17 gm/cc versus 13 gm/cc for tungsten carbide. From 1965 to 1972, the US Army conducted a parallel development program for the 152mm XM578 cartridge which was co-developed with the MBT-70 Tank. The XM578 cartridge used a tungsten alloy that was slightly denser than the British alloy consisting of 97.5 percent tungsten and 2.5 percent binder, which had a density of 18.5 gm/cc.<sup>49</sup>

Throughout the 1960s and early 1970s, the Army developed a successive series of improved 105 mm rounds (the primary main gun caliber on M-60 and developmental XM-1 series tanks) using the denser 97.5% tungsten alloy. The first of these rounds were the XM735 and XM774 cartridges derived from the XM578 cartridge program. These alloys proved sufficient to meet the Army's operational requirements. At the same time, the Army continued to investigate applications for DU.

One of the Army's first uses of DU was as a ballistic weight in the spotting round for the Davy Crockett missile warhead. Additionally, in the early 1960s, the Army tested a four-alloy "UQuad" containing DU in experimental tests on the 105mm and 120mm Delta Armor Piercing Fin Stabilized, Discarding Sabots (APFSDS). Tungsten continued to be favored over DU, however, for two main reasons: 1) DU was still developmental, and inconsistencies with the alloys in the manufacturing process were a persistent problem; and 2) penetration tests against

<sup>49</sup> Richard P. Davitt, *A Comparison of the Advantages and Disadvantages of Depleted Uranium and Tungsten Alloy As Penetrator Materials*, Tank Ammo Section Report No. 107, Dover, NJ: US Army Armament Research and Development Command, June 1980, p. 3.

older Soviet tanks and similar targets failed to show the clear penetration superiority of the DU round.<sup>50</sup>

In the mid-1970s, as it became clear that the latest-generation armors might prove impervious to tungsten carbide penetrators, the Army's focus on improved tungsten alloys began to shift. At the same time, parallel Air Force and Navy tests using smaller-caliber (20-, 25-, and 30mm) ammunition had demonstrated quite convincingly the clear penetration superiority of DU rounds.



Figure 13 - 105mm DU sabot round

In 1973, the Army evaluated alternatives for improving the lethality of its 105mm M68 tank gun. This effort grew into the XM774 Cartridge Program which, after an extensive developmental testing and evaluation program, selected depleted uranium alloyed with  $\frac{3}{4}$  percent by weight titanium (U-3/4Ti). The selection of U-3/4Ti derived in part from improved designs and alloys that allowed the DU core to withstand high acceleration without breaking up. In the 1960s, tungsten alloys used in the XM578 projectile had to be encased in a steel jacket to withstand the extreme firing velocities of the 152mm gun, reducing the penetrating effectiveness of the tungsten cartridge.<sup>51</sup> The new U-3/4Ti alloy overcame these early limitations for large caliber munitions.

Development of U-3/4Ti ushered in a new generation of penetrators for the Army. Since the selection of DU for the XM774 cartridge, all major developments in tank ammunition have selected DU, including the 105mm M833 series and the 120mm M829 series (the latter being the primary anti-armor round used in the Gulf War). This pattern continues today, with the latest generation of the 105mm M900 series and the 25mm M919 for the Bradley Fighting Vehicle.

<sup>50</sup> Richard P. Davitt, A Comparison of the Advantages and Disadvantages of Depleted Uranium and Tungsten Alloy As Penetrator Materials, Tank Ammo Section Report No. 107, Dover, NJ: US Army Armament Research and Development Command, June 1980, p. 5.

<sup>51</sup> Richard P. Davitt, A Comparison of the Advantages and Disadvantages of Depleted Uranium and Tungsten Alloy As Penetrator Materials, Tank Ammo Section Report No. 107, Dover, NJ: US Army Armament Research and Development Command, June 1980, p. 3, 6.



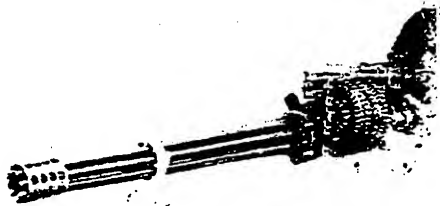


Figure 14 - GAU-8 cannon

In the early 1970s, the Air Force developed the GAU-8/A air to surface gun system for the A-10 close air support aircraft. This unique aircraft, designed to counter the massive Soviet/Warsaw Pact armored formations spearheading an attack into NATO's Central Region, was literally designed and built around the GAU-8. This large, heavy, eight-barreled 30-mm cannon was designed to blast through the top armor of even the heaviest enemy tanks. To further exploit the new cannon's tremendous

striking power, the Air Force opted to use the depleted uranium U-3/4Ti, a 30mm API round. A comprehensive Environmental Assessment of the GAU-8 ammunition was released on January 18, 1976. The report stated that the proposed action was expected to have no significant environmental impact and that the "biomedical and toxicological hazards of the use of depleted uranium (DU) in this program are practically negligible."<sup>52</sup> The A-10 aircraft was deployed to United States Air Forces in Europe (USAFE) in 1978.<sup>53</sup>

The Navy's Phalanx Close-In Weapon System, or CIWS, was designed for terminal (last-ditch) defense against sea-skimming missiles. The Navy evaluated a wide range of materials before deciding on DU alloyed with 2 percent molybdenum (DU-2Mo).<sup>54</sup> Phalanx production started in 1978, with orders for 23 USN and 14 Foreign Military Sales systems; however, subsequent budget cuts reduced these numbers. In 1988 the Navy opted to transition the CIWS 20mm round from DU to tungsten. The Navy made the decision based on live fire tests that showed that tungsten met the Navy's performance requirements while offering reduced probabilities of radiation exposure and environmental impact.<sup>55</sup>

It should be noted that the "soft" targets the CIWS was designed to defeat—anti-ship missiles at close range—are far easier to destroy than "hard" targets like tanks. Substantial stocks of DU ammunition delivered prior to that date remain in the inventory.

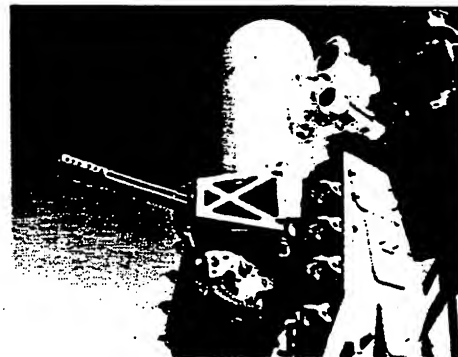


Figure 15 - CIWS system

<sup>52</sup> Environmental Assessment, Depleted Uranium (DU) Armor Penetrating Munitions for the GAU-8 Automatic Cannon, Development and Operational Test and Evaluation, AF/SGPA, April 1975, p. 1.

<sup>53</sup> Richard P. Davitt, A Comparison of the Advantages and Disadvantages of Depleted Uranium and Tungsten Alloy As Penetrator Materials, Tank Ammo Section Report No. 107, Dover, NJ: US Army Armament Research and Development Command, June 1980, p. 5.

<sup>54</sup> "Phalanx Close-In Weapons System," US Navy Fact File Sheet, Public Affairs Office of the Naval Sea Systems Command (OOD), Washington, DC, 1997.

<sup>55</sup> Letter to the Office of the Special Assistant for Gulf War Illnesses from the Commander, Crane Division, Naval Surface Warfare Center, subject: "Navy/Marine Corps Responses to Questions on Depleted Uranium Ammunition." March 17, 1998, Enclosure 1, p. 1.

## ***2. Developmental Tests and Evaluations of the Medical and Environmental Implications of the Use of DU Munitions.***

Although specific requirements have continuously evolved since most current DU weapon systems were in the developmental process, DoD's current acquisition system typifies the highly regulated, deliberate process that these systems followed in their development. Critical components of this process are the comprehensive hazard classification tests, radiological assessments, and life-cycle environmental assessments required by the acquisition process.

The acquisition process is governed by DoD Directive (DoDD) 5000.1, Defense Acquisition; DoD Instruction (DoDI) 5000.2, Defense Acquisition Management Policies and Procedures; and DoD Manual (DoDM) 5000.2-M, Defense Acquisition Management Documentation and Reports. These documents prescribe a comprehensive, iterative process that must be followed in the procurement of defense systems. Starting with a determination of operational requirements, the process proceeds through concept exploration and definition, demonstration and validation, engineering and manufacturing development, production and deployment, and operations and support. Built into the process is the requirement to assess the potential environmental impact and to document system safety, health hazards, and hazardous material that the system design cannot mitigate or eliminate.<sup>56</sup>

The development of the current family of DU weapon systems followed procedures established in the early 1970s. On October 3, 1973, the Office of the Director of Defense Research and Engineering requested that the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) evaluate the medical and environmental implications of the use of DU and alternatives in a variety of conventional munitions. The task force was specifically asked to evaluate the GAU-8A, PHALANX, and BUSHMASTER weapons. This was the first of several medical and environmental assessment of DU. The task force consisted of environmental and medical personnel from the three services and the Atomic Energy Commission. The purpose of the study was to provide a comprehensive medical and environmental evaluation of DU related to the manufacture, transport, storage, use, and disposal of DU munitions.<sup>57</sup>

The overall finding was that the development of DU munitions was expected to have no significant environmental impact. However, depending on local conditions, the uncontrolled release of DU, such as the crash of an A-10 with DU munitions, could have significant impact. JTCG/ME also recommended several follow-on tests to fill in data gaps, in part to assess the environmental impact of uncontrolled release. These tests, conducted in the late 70's, are addressed in Tab L (Research Report Summaries). The following is a summary of JTCG/ME's findings:

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<sup>56</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report. Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, Section 3.3 (Acquisition); pp. 26-32.

<sup>57</sup> Medical and Environmental Evaluation of Depleted Uranium, JTCG/ME Special Report, Vol I, Joint Technical Coordinating Group for Munitions Effectiveness, April 1974, p. v-vi.

- a. The report stated that the pharmacological and toxicological investigation of uranium compounds had resulted in the most thorough and extensive study ever undertaken for this class of weapon. The investigation concluded that uranium was less toxic to humans than originally assessed, and that the toxicity of uranium was due primarily to its chemical rather than radiological properties. It also concluded that uranium did not appear to be any more toxic than lead or other heavy metals. Fragment kinetic energy effects are more significant than any long-term toxicity considerations. The report concluded that the biomedical and toxicological hazards of the use of DU were practically negligible.
- b. The report addressed considerations during the DU manufacturing and transportation process, and concluded that established industrial hygiene practices and safeguards minimized concerns in these areas.
- c. The report acknowledged that in combat situations, the widespread use of DU munitions could create a potential for inhalation, ingestion or implantation (via fragments) problems. However, these problems were viewed as insignificant when compared to the other dangers of combat.
- d. The catastrophic destruction of weapon systems was evaluated for four scenarios: 1) loss of a ship carrying the PHALANX Close-In Weapons System, 2) loss of an ammunition ship carrying DU munitions, 3) loss of an ammunition storage magazine containing DU munitions, and 4) loss of an A-10 aircraft carrying 1,350 DU rounds. The loss of the ships and the magazine were considered to have negligible impact. In the case of the ships, the amount of potential DU release was much less than the amount of uranium normally present in seawater; in the case of the magazine, the structure is designed to contain effects produced by the destruction of the contents. On the other hand, the loss of an A-10 could disperse up to 0.4 metric ton of DU onto the crash site. Removal of the DU could be time consuming and costly depending on the location and circumstances of the crash.<sup>58</sup>

Paragraph c has been cited out of context to bolster claims that the DoD downplayed a known health hazard in order to secure the advantages offered by DU. Comparing "problems resulting from the use of DU" to "the other dangers of the battlefield" does little to promote an understanding of the two very different types of hazards. Whereas the danger from enemy "shooters"—tanks, artillery, etc.—is obvious, the hazard posed by the release of DU requires more thoughtful explanation. Contemporary documentation and studies indicate that while DU could pose a battlefield exposure hazard, that hazard could be prevented or mitigated through simple, field-expedient precautions. Moreover, DU's operational benefits—realized on the Gulf War battlefields—vastly outweigh the risks of exposures encountered during the campaign.

Specific radiological, health, and environmental assessments augmented the JTCG/ME report as the various weapon systems were developed. For example, the Air Force prepared a study titled, *Environmental Assessment, Depleted Uranium (DU) Armor Penetrating Munition for the GAU-8*

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<sup>58</sup> Medical and Environmental Evaluation of Depleted Uranium, JTCG/ME Special Report, Vol I, Joint Technical Coordinating Group for Munitions Effectiveness, April 1974, p. vi-x.

*Automatic Cannon, Development and Operational Test and Evaluation* (April 1975). The environmental assessment (EA) was prepared in accordance with Air Force Regulation 19-2, which complied with the National Environmental Policy Act of 1969. The EA stated that the "biomedical and toxicological hazards of the use of depleted uranium (DU) in this program are practically negligible."<sup>59</sup> Other assessments of the GAU-8 round included a *Hazard Classification Test of GAU-8 Ammunition by Bonfire Cookoff with Limited Air Sampling* (dated February 1976) by Los Alamos Scientific Laboratory (Report # 3 in Tab L) and a study, *External Radiation Hazard Evaluation of GAU-8 API munitions*, performed by the USAF Occupational and Environmental Health Laboratory in 1978 (Report # 4 in Tab L).<sup>60,61</sup>

To support the development of the new generation 105mm armor-piercing cartridge, the Army conducted a series of studies recommended by the JTCG/ME to fill gaps in the existing body of information. The initial three studies were: *Characterization of Airborne Uranium From Test Firings of XM774 Ammunition*, November 1979, (PNL-2944)<sup>62</sup> (Report # 6 in Tab L) *Radiation Characterization, and Exposure Rate Measurements from Cartridge, 105mm, APFSDS-T, XM774*, November 1979 (PNL-2947)<sup>63</sup> (Report # 5 in Tab L); and *Radiological and Toxicological Assessment of an External Heat (Burn) Test of the 105mm Cartridge, APFSDS-T, XM 744 [sic]*, 1978 (PNL-2670).<sup>64</sup>

The aforementioned tests were only the initial investigations into the ecological, environmental, radiological, safety, and health concerns associated with the early DU munitions. For example, the US Army Environmental Policy Institute (AEPI) report on the *Health and Environmental Consequences of Depleted Uranium Use in the US Army* cited three other reports [M.E. Danesi, 1990; US Army Pierre Committee, 1979; and the NMAB of the National Academy of Sciences National Research Council, 1979] that reached similar conclusions to the JTCG/ME report on the health effects of the military use of DU.<sup>65</sup>

In addition to formalized hazard assessments required by DoD directives, the Nuclear Regulatory Commission (NRC) regulates the peacetime handling and use of DU. Currently, the NRC has issued single Master Materials Licenses to the Navy and the Air Force. The Navy and Air Force Radioisotope Committees then issue radioactive material permits to the individual Service

<sup>59</sup> Environmental Assessment, Depleted Uranium (DU) Armor Penetrating Munition for the GAU-8 Automatic Cannon, Development and Operational Test and Evaluation. AF/SGPA, April 1975, Executive Summary, p. i.

<sup>60</sup> J.C. Elder, M.I. Tillery, and H.J. Ettinger. Hazard Classification Test of GAU-8 Ammunition by Bonfire Cookoff with Limited Air Sampling, LA-6210-MS. Los Alamos, NM: Los Alamos Scientific Laboratory of the University of California, February 1976.

<sup>61</sup> Captain Karl L. Prado, External Radiation Hazard Evaluation of GAU-8 API Munitions, TR 78-106. Brooks AFB, TX: USAF Occupational and Environmental Health Laboratory, 1978.

<sup>62</sup> Characterization of Airborne Uranium from Test Firings of XM774 Ammunition (PNL-2944), November 1979.

<sup>63</sup> Radiation Characterization, and Exposure Rate Measurements from Cartridge, 105mm, APFSDS-T, XM774, (PNL-2947), November 1979.

<sup>64</sup> Radiological and Toxicological Assessment of an External Heat (Burn) Test of the 105mm Cartridge, APFSDS-T, XM 744 [sic], (PNL-2670) 1978.

<sup>65</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report. Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 92-93.

activities handling DU. On the other hand, the Army currently has 14 individual NRC licenses issued directly to each organization responsible for the management of DU. The individual Services and the NRC monitor compliance with NRC regulations and the license-specific requirements through periodic, on-site inspections. Although specific requirements vary from site to site, typical requirements include supervision and oversight of procedures involving DU by qualified radiation protection officers, the posting of areas containing DU munitions, and periodic leak testing of stored munitions.

Throughout the development of the DU weapons program, DoD has followed its acquisition directives and conducted extensive hazard assessment. The Services fielded DU munitions and armor only after rigorous testing and evaluation that carefully considered their environmental impact and potential for battlefield contamination. The fact that DU exposures took place during the Gulf War is not indicative of a haphazard or incomplete development, testing, or evaluation regime. Rather, exposure issues were typically the result of the Services' failure to properly disseminate cautionary information and warnings to the decision-makers and operators whose duties might expose them to DU contamination, and to practice better risk management.

### *3. Current Uses of DU*

DU is currently used in kinetic cartridges for the Army's 25mm BUSHMASTER cannon (M2/3 Bradley Fighting Vehicle), the 105mm cannon (M1 and M60 series tanks) and the 120mm cannon (M1A1 and M1A2 Abrams Tank). The Heavy Armor variant of the M1A1, the M1A1 (HA), also employs layered DU for increased armor protection. Army Special Forces also use small caliber DU ammunition on a limited basis. The Marines use DU tank rounds in their own M1-series tanks as well as a 25mm DU round in the GAU-12 Gatling gun on Marine AV-8 Harriers. The Army uses small amounts of DU as an epoxy catalyst for two anti-personnel mines: the M86 Pursuit Deterrent Munition and the Area Denial Artillery Munition.<sup>66</sup> The Air Force uses a 30mm DU round in the GAU-8 Gatling gun on the A-10. The 20mm DU round developed by the Navy for use in its shipboard PHALANX Close In Weapons System (CIWS) remains in service; however, since FY 1990, the Navy has procured only tungsten rounds for the CIWS. The 20mm DU rounds remaining in the inventory will be used until the supply is exhausted or ages beyond its service life.<sup>67</sup>

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<sup>66</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report, Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 25.

<sup>67</sup> Letter to the Office of the Special Assistant for Gulf War Illnesses from the Commander, Crane Division, Naval Surface Warfare Center, subject: "Navy/Marine Corps Responses to Questions on Depleted Uranium Ammunition." March 17, 1998, Enclosure 1, p. 1.

DU is also used in numerous commercial applications:<sup>68, 69</sup>

- ballast and counterweights
- balancing control services on aircraft (civilian and military)
- balancing and vibration damping on aircraft
- machinery ballast and counterweights
- gyrorotors and other electromechanical counterweights
- neutron detectors
- radiation detection and shielding for medicine and industry
- shielding for shipping containers for radiopharmaceuticals, radioisotopes, and spent nuclear fuel rods
- chemical catalyst
- X-ray tubes
- glass and ceramics for brilliant colors

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<sup>68</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report, Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 25.

<sup>69</sup> Reed C. Magness. Environmental Overview for Depleted Uranium, CRDC-TR-85030, Aberdeen Proving Ground, MD: Chemical Research & Development Center, October 1985, p. 10-12.

## ***Tab F - DU Use in the Gulf War***

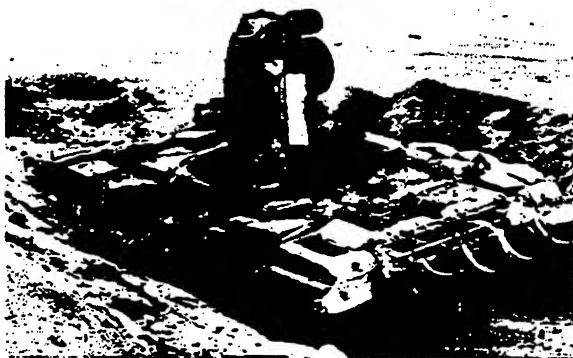


Figure 16 - Iraqi T-72 hit with DU sabot

Operation Desert Storm was the first conflict to see the extensive use of DU munitions and armor packages. The new rounds gave coalition forces a marked operational advantage. Unit histories from the Gulf War contain many anecdotes attesting to the effectiveness of DU "silver bullets." One armor Brigade Commander described looking on in "amazement" as his soldiers (who in training had never fired at targets beyond 2,400 meters [1.5 miles]) routinely scored first-shot kills on targets out to 3,000 meters (1.9 miles) and beyond.<sup>70</sup> DU armor gained an equally impressive reputation. A story illustrating DU's offensive and defensive renown involves a heavy armor M1A1 tank that had become mired in the mud.

The unit (part of the 24<sup>th</sup> Infantry Division) had gone on, leaving this tank to wait for a recovery vehicle. Three T-72's appeared and attacked. The first fired from under 1,000 meters, scoring a hit with a shaped-charge (high explosive) round on the M1A1's frontal armor. The hit did no damage. The M1A1 fired a 120mm armor-piercing round that penetrated the T-72 turret, causing an explosion that blew the turret into the air. The second T-72 fired another shaped-charge round, hit the frontal armor, and did no damage. The T-72 turned to run, and took a 120mm round in the engine compartment and blew the engine into the air. The last T-72 fired a solid shot (sabot) round from 400 meters. This left a groove in the M1A1's frontal armor and bounced off. The T-72 then backed up behind a sand berm and was completely concealed from view. The M1A1 depressed its gun and put a sabot round through the berm, into the T-72, causing an explosion.<sup>71</sup>

The Army, Air Force, Navy and Marines all used DU to some extent in the Gulf.

<sup>70</sup> Robert H. Scales, Jr., Certain Victory: The US Army in the Gulf War. Simon & Schuster, Pocket Books, 1992, p. 293.

<sup>71</sup> James F. Dunnigan and Austin Bay, From Shield to Storm: High-Tech Weapons, Military Strategy, and Coalition Warfare in the Persian Gulf. William Morrow & Company, 1992, p. 294-295.

## A. Army



Figure 17 - M1A1 tank engages a target

During the Gulf War, the Army used DU for both defensive and offensive purposes. According to DoD's report to Congress, *Conduct of the Persian Gulf War*, 594 of the 1,772 M1A1 series tanks deployed to the Gulf were heavy armor Abrams variants.<sup>72</sup> DU armor packages on these heavy armor tanks provided their crews with added protection. During Operation Desert Storm, there were no penetrations of DU armor by Iraqi fire.<sup>73</sup>

The Army used 105mm (M900) and 120mm (M829 and M829A1) ammunition with DU penetrators, in addition to non-DU rounds such as High Explosive Anti Tank (HEAT) shells, in Abrams tanks. Since DU rounds are not fired in training, the Gulf War was the tankers' first chance to fire the round. As word of the DU sabot round's effectiveness spread, it quickly became the round of choice for US tankers.

The number of DU rounds expended in combat has not been determined. Units requested ammunition as needed, and were not required to record cumulative expenditures. However, the total quantity of DU rounds used in the Gulf before (during pre-combat live-fire training), during, and after the Gulf War was recorded and allows a reasonable estimate of rounds expended. The officer in charge of all ground force ammunition in theater tracked the numbers of rounds by type shipped, rounds returned after the war, and rounds left in theater as war reserve stocks. Table 5 shows ground force ammunition usage as reported by the Theater Ammunition Officer. Tank ammunition consumed by the US Marines does not show up on the graphic, since the Marines had tank ammunition pre-positioned on ships. As they expended this initial allocation, the Marines were resupplied from Army stocks. Numbers in Table 5 include these

<sup>72</sup> Final Report to Congress, Conduct of the Persian Gulf War, Washington, DC: Department of Defense, April 1992, p. 750.

<sup>73</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report. Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 76.



diverted rounds, but not the initial Marine stocks, whose quantities are currently unknown. As indicated in Table 5 below, the US Army fired 9,552 DU tank rounds, totaling approximately 50 tons of DU. This amount of DU would fit in a box with length, width and height dimensions all equal to four and a half feet.

**Table 5- DU Consumed by Army in the Gulf During ODS/DS<sup>74</sup>**

Ammunition Type (rounds)	Shipped (rounds)	Left on Ship (rounds)	Left with Reserve Stock (rounds)	Returned after Gulf War (rounds)	Consumed in the Gulf (rounds)	DU used in the Gulf (tons) <sup>75</sup>
M900 (105mm)	2,314	0	0	1,810	504	2.14
M829 (120mm)	141,247	5,900	1,800	126,847	6,700	35.85
M829A1 (120mm)	89,473	0	0	87,125	2,348	12.56
Total	233,034	5,900	1,800	215,782	9,552	50.55

## B. Air Force



Figure 18: - A-10 "Warthog" in the Gulf

The Air Force fired 30mm Armor Piercing Incendiary (API) munitions using a DU penetrator slug from the GAU-8 Gatling gun mounted on the A-10 Aircraft (Figure 18). The 148 A-10s that deployed to Saudi Arabia flew 8,077 combat sorties. A typical combat load would include 1,100 rounds of 30mm high explosive or armor piercing ammunition for the GAU-8.<sup>76</sup> 30mm API is mixed with 30mm High Explosive Incendiary (HEI) at the factory and is called Combat Mix Ammunition. The ratio

of API to HEI rounds in the Combat Mix is 4:1. The Air Force fired a total of 783,514 rounds of 30mm API in the Gulf War.<sup>77</sup> Since each round contains approximately 0.6 pounds of DU, the Air Force expended a total of 235 tons of DU in the Gulf.

<sup>74</sup> "Estimated Expenditure" spreadsheet faxed to investigators by former Theater Ammunition Officer, February 3, 1992, p. 4.

<sup>75</sup> Based on weights per round of 8.5 pounds of DU for the 105mm and 10.7 pounds for the 120mm, taken from: Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report. Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 39.

<sup>76</sup> Final Report to Congress, Conduct of the Persian Gulf War, Washington, DC: Department of Defense, April 1992, p. 664.

<sup>77</sup> Memorandum from Headquarters Ogden Air Logistics Center, Department of the Air Force, Subject: "Gulf War Depleted Uranium DU Munitions Expenditure" April 30, 1997.

### C. Navy

The Navy deployed its shipboard Phalanx CIWS (Close-In Weapon System) to the Gulf. The Phalanx's 20mm cannon used both DU and tungsten rounds. The weapon was test fired over the Gulf, and during an accidental discharge of 4-5 shells that took place as Navy ships were responding to the launch of a shore-based anti-ship missile.<sup>78</sup> The errant firing marked the only time the CIWS was fired "in anger" during the Gulf War.<sup>79</sup>

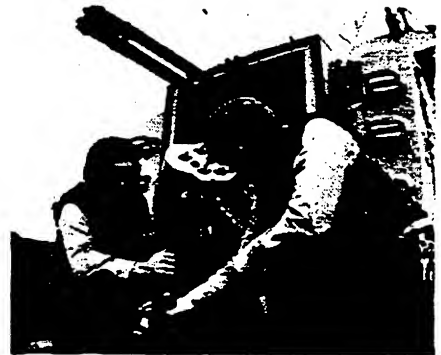


Figure 19 – CIWS in the Gulf

### D. Marines



Figure 20 - USMC M1A1

The USMC deployed to the Gulf with older M-60 tanks. To augment their armor capabilities, the Marines borrowed 60 heavy armor M1A1 Abrams tanks from the US Army. In addition, the Marines took early delivery of 16 M1A1s already on order, rushing the new tanks to the Gulf and conducting transition training for former M-60 tank crews. The 2nd Tank Battalion and elements of the 4th Tank Battalion employed a total of 76 M1A1 tanks.<sup>80</sup> Initially, these tanks drew on pre-positioned, shipboard munitions stocks that included DU. As these stocks were expended, the Marines drew resupply rounds from Army munitions stocks.

Eighty-six AV-8B Harrier aircraft deployed to the Gulf, flying 3,342 sorties.<sup>81</sup> According to HQ Marine Corps, Department of Aviation, the Marine Corps fired 67,436 rounds of PGU/20 (a 25mm DU round) in the Gulf War.<sup>82</sup> The AV-8B fired an equal mix of DU and HE rounds. Each 25mm DU round contains 148 grams (.33 pounds) of DU, so the Marine aviators expended 11 tons of DU in the Gulf War.<sup>83</sup>

<sup>78</sup> Lead Sheet # 14246, Interview of former USS Missouri Executive Officer, January 23, 1998.

<sup>79</sup> US Navy Fact File, "Phalanx Close-In Weapons System," Public Affairs Office, Naval Sea Systems Command, Washington, DC, May 1996.

<sup>80</sup> M1A1 Main Battle Tank, USMC Fact File, HQ USMC, Division of Public Affairs, Washington, DC, May 1991.

<sup>81</sup> Final Report to Congress, Conduct of the Persian Gulf War, Washington, DC: Department of Defense, April 1992, p. 671-2.

<sup>82</sup> Lead Sheet # 5683, Interview of an officer from the HQ Marine Corps, Department of Aviation, Aviation Support Logistics, May 9, 1997.

<sup>83</sup> Lead Sheet # 5684, Interview of Master Sergeant from the HQ Marine Corps, Department of Aviation, Aviation Support Logistics, May 9, 1997.

## E. Use by Other Countries

The only other country known to have fired DU munitions in the Gulf War is the United Kingdom. The UK Ministry of Defence's latest assessment is that its Challenger tanks fired fewer than 100 120mm Armor Piercing Fin Stabilized Discarding Sabot (APFSDS) rounds against Iraqi military forces during hostilities, although additional rounds were fired during earlier work-up training in Saudi Arabia. This equates to less than one (US) ton of DU.<sup>84</sup>



Figure 21 – UK Challenger tank

In 1990-1991, the US had a near-monopoly on the use of DU. When this report attributes damage or destruction to DU, it can be assumed that US systems were responsible. No Coalition vehicles or personnel were engaged or struck by DU munitions fired from US tanks and aircraft. Iraq did not have DU armor or munitions in its inventory.

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<sup>84</sup> Fax from Gulf War Veteran's Illnesses Unit, UK Ministry of Defence, London, July 16, 1998, p. 1.

## ***Tab G – DU Exposures in the Gulf***

Gulf War personnel were exposed to DU in a number of ways. Some US combat vehicles were mistakenly destroyed or damaged by US tanks using DU sabot rounds. Personnel worked inside US vehicles contaminated with DU fragments and particles. Several accidental tank fires and an ammunition explosion/fire at Camp Doha, Kuwait, resulted in DU rounds being burned, oxidized, or fragmented, which created a potential exposure hazard to troops operating in the vicinity. Other troops entered Iraqi armor disabled by DU. Determining the medical consequences of these exposures, if any, requires a systematic, scientifically sound evaluation. The exposure scenarios observed during ODS/DS and in months following, were categorized into three levels based on the activities of the soldiers involved, and the resulting potential for direct contact with DU. These three exposure levels provided a prioritized approach to describing and evaluating the potential exposures that occurred:

Level I - Soldiers in or near combat vehicles at the time these vehicles were struck by DU penetrators, or who entered vehicles immediately after they were struck by DU munitions. These soldiers could have been struck by DU fragments, inhaled DU aerosols, ingested DU residues, or had DU particles land on open wounds, burns, or other breaks in their skin.

Level II - Soldiers and a small number of DoD civilian employees who worked in and around vehicles containing DU fragments and particles (mostly friendly fire wrecks). These soldiers may have inhaled DU residues stirred up (resuspended) during their activities on or inside the vehicles, transferred DU from hand to mouth, thus ingesting it, or spread contamination on their clothing. Soldiers who were involved in cleaning up DU residues remaining on Camp Doha's North Compound after the July 11, 1991, explosion and fires are also included in this group.

Level III - An "all others" group whose exposures were largely incidental (fleeting). This group includes individuals who entered DU-contaminated Iraqi equipment, troops downwind from burning Iraqi or US equipment struck by DU rounds, or downwind from burning DU ammunition, such as soldiers at Doha during the July 11 fire. While these individuals could have inhaled airborne DU particles, the possibility of receiving an intake high enough to cause health effects is extremely remote.

As research progressed, 13 categories of possible DU exposure were identified and classified within the three levels as shown in Table 1 (page 8). These categories are described below.

### **A. Level I Participants**

Eight friendly fire incidents involving DU munitions are known to have occurred during the Gulf War. These incidents (distinct from non-DU friendly fire incidents or cases where friendly vehicles were evacuated and then deliberately destroyed to prevent their capture) resulted in the contamination of six M1/M1A1 tanks and 15 Bradley Fighting Vehicles. Another M1A1 was hit by a large shaped-charge round, believed to be a Hellfire missile fired from an Apache

helicopter, that ignited an on-board fire. This incident is described in the "Tank Fires" section. Darkness and low visibility caused by heavy rains, sandstorms, etc., were major contributing factors in all of these incidents.<sup>85</sup>



Figure 22 - M1A1 lost to friendly fire

In most cases, owing to battlefield confusion, soldiers manning the targeted vehicles initially believed that the Iraqis had fired the shots that penetrated their armor. The distinctive radioactive trace DU leaves on the entrance and exit holes allowed a team of battle damage assessment experts to determine (after the fact) which vehicles had been hit by DU sabot rounds fired from Abrams tanks. After-action investigations and word-of-mouth reporting among the units involved

generally resulted in the affected soldiers learning that they had been victims of friendly fire. Not all of these soldiers, however, were aware of the potential health effects associated with DU. Therefore, the investigation of friendly fire incidents is being accompanied by an effort to identify, locate, and contact all surviving soldiers who were in or on vehicles at the time they were penetrated by DU rounds.

Level I soldiers, injured or not, were in or around combat vehicles at the time they were struck by DU sabots, or immediately afterward. Besides the embedded fragments from wounds, these individuals may have inhaled DU aerosols generated by fires or by the impact of the DU projectile penetrating the target. The following discussion describes the circumstances under which Level I soldiers were mistakenly targeted by US tank crews

As the "spearpoint" of the ground campaign, US armored crews were often forced to make very rapid "friend or foe" decisions, where failure to engage could allow enemy gunners to take a fatal shot. Invariably, given the swirling meeting engagements and close-in fights that erupted between friendly and enemy units, tragic misidentifications occurred. A total of 21 US combat vehicles (6 Abrams tanks and 15 Bradley Armored Fighting Vehicles or Cavalry Scout vehicles) were struck by 120mm DU sabot rounds fired from US M1A1 tanks. Some of these vehicles were struck once, others, several times. Based on typical manning configurations for the Abrams tanks and Bradleys<sup>86</sup> as well as information gathered from veterans, an estimated 113 soldiers

<sup>85</sup> "Military Probes Friendly Fire Incidents" Washington, DC: Office of the Assistant Secretary of Defense, Public Affairs: News Release, August 13, 1991.

<sup>86</sup> M1A1 Abrams tanks have a four-man crew (commander, driver, gunner, loader). Bradleys configured as armored fighting vehicles (M2 variant) carry a crew of three (commander, driver, gunner) and six "dismount" infantry in the rear compartment. Bradleys configured as M3 cavalry scout vehicles carried two observers in the rear, in addition to the three-man crew (commander, gunner, driver).

were on board these combat vehicles at the time that they were struck by DU penetrators. Actual manning at the time of the friendly fire incidents varied, since crewmembers and dismount infantry often left the vehicle, or vehicles picked up the occupants of disabled vehicles. Table 6 lists the individual systems struck by DU and their estimated manning. Reports have suggested that at least one vehicle was struck initially by enemy fire, evacuated, and subsequently struck by a DU round. If these reports are verified, the numbers reported in Table 6 may go down.

**Table 6 - Summary of US vehicles hit by DU tank rounds**

Army Unit	Vehicle Type	Bumper Numbers	Estimated Soldiers Onboard
4-7 Cavalry	Bradley	A-24, A-31, & A-22	15
1-37 Armor	Abrams	C-12	4
1-41 Infantry	Bradley	B-21, B-26, B-33, D-21 & D-26	30
3-66 Armor	Abrams	B-66, B-22, A-14, A-31 & A-33	20
3-15 Infantry	Bradley	C-11, C-22 & C-23	25
4-66 Armor	Bradley	HQ-55 & HQ-54	9
1-34 Infantry	Bradley	HQ-232	5
2-2 Cavalry	Bradley	G-14	5
		Total	113

Level I participants are separated into two categories: soldiers who were in or on combat vehicles at the time they were struck by DU rounds, and soldiers who entered those vehicles immediately afterwards to rescue wounded comrades. Since the former are believed to have incurred the highest risk from embedded DU fragments and/or inhalation of the DU aerosols resulting from penetrator impact, this group will be discussed first.

### **1. Soldiers in Vehicle on Impact.**

Armor crewmen and the "dismounted" infantry transported in Bradley Fighting Vehicles supplied the offensive striking power for Operation Desert Storm. The highly mechanized US armored and mechanized infantry units counted on the speed, mobility, and firepower of their Bradleys and Abrams to maintain a rapid rate of advance while engaging and neutralizing enemy formations standing between Coalition troops and their objectives.

### **2. Soldiers Entering Vehicles Immediately After Impact.**

Friendly fire incidents were usually witnessed by other US soldiers who in most cases served in the same platoon or company as the struck combat vehicle. Typically these troops would rush to the aid of the stricken vehicle's occupants to perform emergency first aid and rescue operations. The responding troops often entered damaged or destroyed vehicles moments after they had been hit, raising concerns that they may have been exposed to DU residues or oxides still airborne

from impacts, or stirred up by the activities of survivors and rescuers inside and outside the vehicles. An estimated 30-60 soldiers are currently believed to be included in this category.

## **B. Level II Participants**

This category includes soldiers who worked in and around DU-contaminated vehicles (mostly friendly fire wrecks). It also includes personnel who took part in the clean-up of DU contamination from the motor pool pads at Camp Doha, Kuwait, after several hundred rounds of DU sabot ammunition were detonated or burned in an explosion and fire on July 11, 1991.

A total of 16 Abrams and 15 Bradleys (Table 7) were contaminated with DU in the Gulf during 1990-1991. In addition to the accidental friendly fire vehicles mentioned earlier, three bogged-down Abrams were deliberately destroyed by other US tanks (after their crews had evacuated) to

**Table 7 - DU Contaminated Vehicles**

Reason for Contamination	Abrams	Bradleys
Accidental Friendly Fire	6	15
Intentional Friendly Fire	3	0
Tank Fire Caused by Hellfire	1	0
Accidental Tank Fires	3	0
Tanks Burned in Doha Fire	3	0
Total	16	15

prevent them from falling into Iraqi hands. The Level II group also includes personnel whose maintenance or salvage duties required them to frequently enter and exit, or spend extended periods of time working in, contaminated vehicles. Finally, soldiers who cleaned up DU residues or spent penetrators inside Camp Doha's North Compound following the July 1991 ammunition supply point explosion/fire, fall under this classification.

### **1. Downloading Munitions.**

Explosive Ordnance Disposal (EOD) personnel entered DU-contaminated vehicles. This group should have been aware of DU hazards. EOD personnel were trained and equipped to operate in a nuclear as well as DU-contaminated environment. Unfortunately, the EOD troops may not have been aware in every case that the vehicles they were working in had been struck by DU. The exposure of EOD personnel remains under investigation by this office.

### **2. Inspection and Maintenance Operations**

A number of individuals entered US equipment contaminated with DU within hours or days of penetrator impact. Unit personnel usually entered destroyed or damaged systems to recover sensitive equipment or to salvage undamaged system components. These individuals were not only potentially exposed to DU dust, but also may have inadvertently spread parts and equipment containing trace amounts of DU to other vehicles. One member of the Battle Damage Assessment Team said that more than 27 major components had been removed from the first four Bradleys he inspected (three of the Bradleys were considered contaminated with DU).<sup>87</sup>

<sup>87</sup> Lead Sheet #15330, Interview of a Major in the Battle Damage Assessment Team, March 5, 1998, p. 2.

Investigators are currently compiling a list of maintenance soldiers who entered contaminated tanks or Bradleys. At least one or two maintenance personnel are believed to have entered each contaminated vehicle.

### **3. Logistics Assistance Representatives (LARs)**

In addition to unit maintenance personnel, a number of LARs (Logistics Assistance Representatives) also entered damaged or destroyed vehicles. Civilian systems experts deployed to the Gulf Theater on behalf of the Department of the Army. These personnel were often called upon to determine the disposition of knocked-out equipment. Because the LARs had more direct communication with the Army Munitions and Chemical Command (AMCCOM), they were more aware of DU hazards and the proper procedures for mitigating those hazards. A December 20, 1990, message to the LARs advised them on the proper assessment, repair and recovery techniques:

The number of personnel who take part in the vehicle recovery should be kept to an absolute minimum. They are to be dressed in protective coveralls, gloves, rubberized boots, and they are to also wear the M25 or M17A2 protective mask with M13A2 filter element and the accompanying head covers (i.e., Mission Oriented Protective Posture [MOPP] level 4). The coverall pant legs are to be worn over the rubber boots and sealed with tape at the ankles. Likewise, the sleeves are to be slipped over the gloves and taped. The edges of the hood are to be draped over the coveralls and taped to them and the place where it contacts the respirator. Also, any remaining openings are to be sealed with tape.<sup>88</sup>

Despite this guidance, at least one LAR has stated that he entered contaminated systems in a tee shirt and without a respirator.<sup>89</sup> When interviewed, the deputy to the officer in charge of M1-series tank LARs stated that, despite warning messages that highlighted the potential exposure risks to DU, he had received numerous reports after the war of his LAR personnel entering damaged Abrams tanks without proper protective equipment.<sup>90</sup> Efforts are continuing to identify, interview, and assess the DU exposure potential of these LARs.

### **4. Battle Damage Assessment Teams**

A group from the US Army Ballistics Research Laboratory (BRL) at Aberdeen, Maryland, conducted battle damage assessments on damaged or destroyed US ground combat vehicles. This 12-man BDAT (Battle Damage Assessment Team) looked at damaged and destroyed US combat vehicles to determine how they had been knocked out, what damage had been sustained, the type of weapon/munition used, the effectiveness of survivability features, etc. These close, in-depth inspections entailed frequent entry into disabled, often DU-contaminated vehicles. The

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<sup>88</sup> Memorandum from the Chief of the Log Ops. Branch, Subject: "Safe Response to Incidences Involving Depleted Uranium Armor/Ammo," December 20, 1990.

<sup>89</sup> Lead Sheet #5685, Interview of a LAR from 1<sup>st</sup> AD, July 8, 1997.

<sup>90</sup> Lead Sheet #5742, Interview of an AMCCOM (now IOC) representative, July 9, 1997.



BDAT Team was trained in proper handling procedures and safeguards for DU-damaged equipment.<sup>91</sup> Some members of the BDAT followed the prescribed precautions and only entered DU-contaminated tanks after donning yellow radiation suits including dust masks, gloves, and boots. Other members were not as rigorous in taking protective measures. Assessments typically took between six and eight hours to complete.<sup>92</sup> The BDAT arrived in the Gulf on or about January 21, 1991, and were attached to combat elements prior to the ground war. Because the BDAT personnel had more technical expertise with DU than most soldiers, they were sometimes called in to help evaluate potential crew and equipment radiation contamination and to assist in friendly fire investigations.

## **5. Processing Damaged Equipment**

Disabled or destroyed US combat vehicles were transported to King Khalid Military City (KKMC), the central receiving and storage site for all damaged/destroyed US combat vehicles (and many Iraqi "trophy tanks"). The 144<sup>th</sup> Service and Supply Company, a National Guard unit from New Jersey, was tasked to assess battle damage and prepare the vehicles for shipment back to the US. Although their mission did not include maintenance or repair, members of the 144<sup>th</sup> have indicated that they periodically re-entered the contaminated vehicles to cannibalize equipment for other units.<sup>93</sup> The 144<sup>th</sup> personnel were not familiar with proper procedures for handling DU-contaminated M1-series tanks or Bradleys. Because their original mission did not involve tanks with DU armor, the unit did not have any copies of Army Technical Bulletin (TB) 9-1300-278<sup>94</sup> that contained guidance for handling DU-contaminated M1 tanks.<sup>95</sup>

The 144th worked on DU-contaminated equipment without taking any precautions (e.g., wearing dust masks). They reportedly had no knowledge that some of the damaged equipment was contaminated with DU until after March 11, 1991. In many cases, contaminated equipment was interspersed with uncontaminated vehicles. Until the arrival of a radiation control (RADCON) team from the Armament Munitions and Chemical Command (AMCCOM), access to the equipment was not controlled. As many as 27 soldiers in the 144<sup>th</sup> worked in or around damaged Bradleys and Abrams without protective gear for an undetermined period of time.<sup>96</sup> Although the BDAT commander stated that he informed personnel from the unit about the hazard from contaminated vehicles on or about March 11, 1991, various members of the 144<sup>th</sup> have questioned the date they were actually notified, and stated that they continued to enter

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<sup>91</sup> Lead Sheet #5681, Interview of the BDAT Officer in Charge, August 1, 1997.

<sup>92</sup> Lead Sheet #15330, Interview of a Major in the Battle Damage Assessment Team, March 5, 1998, p. 2.

<sup>93</sup> Lead Sheet # 14316, Interview of 144<sup>th</sup> Services and Supply Company NJANG NCO, January 28, 1998.

<sup>94</sup> This is the US Army "Guidelines For Safe Response to Handling, Storage, and Transportation Accidents Involving Army Tank Munitions or Armor Which Contain Depleted Uranium, Department of the Army"

<sup>95</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report, Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 81.

<sup>96</sup> Operation Desert Storm - Army Not Adequately Prepared to Deal With Depleted Uranium Contamination, GAO/NSIAD-93-90, Washington, DC: United States General Accounting Office, Report to the Chairman, Subcommittee on Regulation, Business Opportunities, and Energy, Committee on Small Business, House of Representatives, January 1993, p. 17.

contaminated equipment after this date.<sup>97</sup> The exact date will probably never be confirmed due to the intervening time period and lack of documentation.

## 6. Radiation Control Activities.

After completing their initial battlefield assessments, the Battle Damage Assessment Team went to KKMC on March 11, 1991, to see if any equipment they had missed had been evacuated to the vehicle collection point, which was being managed by the 144<sup>th</sup> Service and Supply Company. Finding many DU- contaminated vehicles at KKMC, the BDAT requested on-site AMCCOM personnel to arrange for an AMCCOM radiation control (RADCON) team to be sent to KKMC.<sup>98</sup>

AMCCOM deployed RADCON teams to identify, assess, and respond to incidents involving DU contamination. RADCON teams performed their duties primarily at King Khalid Military City (KKMC) and at Camp Doha, although limited excursions to other locations occurred.

On March 24, 1991, a RADCON team of health physicists from AMCCOM arrived to assume responsibility for identifying, collecting, and surveying DU-contaminated equipment.<sup>99</sup> Much of this equipment was already at KKMC. The AMCCOM RADCON team segregated the DU-contaminated vehicles, set up a guarded perimeter to restrict access, and instructed 144<sup>th</sup> personnel in the proper handling of DU. The team examined the vehicles at the site and concluded that their DU radiological and chemical contamination levels, while low, required basic protective equipment, such as surgical gloves and dust masks, and strict personal hygiene measures.<sup>100</sup> Their work, completed around April 12, 1991, cleared the way for contract personnel to inspect, decontaminate, package, and retrograde the contaminated systems to the US.<sup>101</sup> In all, 15 Bradleys and 10 Abrams at KKMC were contaminated with DU. Some merely had DU "splatter" and could be returned to duty after decontamination. Others had to be sealed to contain the contaminant, then shipped to the US for final processing and disposal.<sup>102</sup>

The AMCCOM personnel also surveyed captured Iraqi equipment being prepared for shipment to the US. According to the person in charge of the survey operation, the most acute radiological hazard on these Soviet-built tanks was radium used in their gauges, which were often leaking.

<sup>97</sup> Lead Sheet #14200, Interview of the Platoon Leader of the Operations Center of the 144<sup>th</sup> Services and Supply Company NJANG Storage Yard at KKMC, January 19, 1998.

<sup>98</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 10-11.

<sup>99</sup> Memorandum for AMSMC-TM from the DU Team SWA, Subject: "DU Team Accomplishments," April 12, 1991.

<sup>100</sup> Radiological Team Report, AMCCOM (US Army Armaments, Munitions, and Chemical Command). Undated.

<sup>101</sup> Memorandum for Deputy Chief of Staff for Readiness, Headquarters, US Army Material Command, Subject: Depleted Uranium (DU) Contaminated Equipment, April 24, 1991.

<sup>102</sup> Memorandum for AMCCOM-SWA from AMSMC-SF, Subject: "Contaminated Vehicle Retrograde Actions," May 23, 1991.

These gauges had to be removed prior to shipping. One T-72 tank had substantial internal and external DU contamination.<sup>103</sup> It was not shipped, but its ultimate fate is unknown.<sup>104</sup>

An AMCCOM recovery team deployed to Camp Doha, Kuwait, from July 19 until early August 1991. The team did a radiological survey in and around four M1A1 tanks that were damaged or destroyed in the July 11 fire. After determining that three of the tanks contained low-level contamination, the AMCCOM team did an initial decontamination of their exteriors and prepared them for shipment to the port of Dammam. A sizeable quantity of spent DU penetrators and fragments were also collected from the 2<sup>nd</sup> Squadron motor pool pad, and deposited in the tanks' interior, which were then sealed. On August 6 the tanks were shipped from Dammam and returned to the US for processing at the Defense Consolidation Facility at Snelling, SC.<sup>105</sup>

On July 24, a RADCON Emergency Response Team from the US Army's Communications-Electronics Command (CECOM) Safety Office at Ft. Monmouth, NJ, arrived at Camp Doha.<sup>106</sup> The CECOM team was headed by the Project Director for the US Army Radiological Control Team. The team conducted what one member called a "site characterization survey."<sup>107</sup> This was not a grid-by-grid survey, but rather a more general survey, mostly in and around the motor pool. Nevertheless, the CECOM team was able to survey and clear an estimated two acres of the motor pool (which was the size of several football fields).<sup>108,109</sup> Investigators have interviewed several members of the AMCCOM and CECOM RADCON teams. All interviewed used some form of personal protection, although only about half routinely used respiratory protection while working in and around contaminated vehicles.<sup>110</sup> Based on studies done before the war, the likelihood of stirring up DU dust was thought to be negligible. All team members interviewed said that they were careful to survey each other with a RADIAC meter at the end of each work day to ensure that they were not tracking DU residues away from the taped-off portion of the 2<sup>nd</sup> Squadron motor pool pad. Ten to twelve personnel performed radiation control activities at one time or another. Investigators from the Office of the Special Assistant are continuing their efforts to locate and interview these personnel.

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<sup>103</sup> Memorandum for SCR AMC-SWA, Subject: "Decontamination and Retrograde Movement of Destroyed T-72 Tank," (Undated).

<sup>104</sup> Lead Sheet #5680, Interview of US Army Major in charge of surveying captured Iraqi equipment designated for shipment to the US, August 1, 1997.

<sup>105</sup> Lead Sheet 5698, Interview of former AMCCOM team member, August 8, 1997; and Lead Sheet 5699, Interview of AMCCOM Team Chief, July 25, 1997.

<sup>106</sup> Letter to US Army CECOM Office of the Chief of Staff, July 26, 1991.

<sup>107</sup> Lead Sheet 5993, Interview of former CECOM Team Member, August 7, 1997.

<sup>108</sup> Lead Sheet 5993, Interview of former CECOM Team Member, August 7, 1997 and Lead Sheet 5997, Interview of former CECOM Team Chief, July 16, 1997.

<sup>109</sup> Memorandum for Commander, Task Force Victory (Fwd), Subject: "Camp Doha Accident Survey Update," August 2, 1991, p. 1.

<sup>110</sup> Lead Sheet # 5513, Multiple interviews of former Theater health physicist, between July 1997 and March 1998, and RADCON personnel deployed to the Gulf (Lead Sheets 5698, 5699, 5700, 5701, 5703, and 5719).

## **7. Camp Doha Cleanup Activities.**

A July 11, 1991 fire in Camp Doha's motor pool complex (the North Compound) destroyed or damaged tons of ammunition as well as 20-30 combat loaded vehicles and dozens of trucks and other support vehicles and equipment. One M1A1 tank was damaged and three destroyed in the fire. The three destroyed tanks were also contaminated since their "combat load" of DU rounds (an estimated 37 M829 sabot rounds per tank) had cooked off. In addition to the estimated 111 rounds in the tanks, more than 500 M829 rounds stored in nearby conexes (metal shipping containers) were also damaged or destroyed. Most of these rounds had detonated, leaving behind a scorched, exposed DU penetrator rod. In most cases these exposed rods showed little oxidization; however, a number were oxidized or fragmented to various degrees.

Within the North Compound, almost all of the DU penetrators, fragments, and oxides were concentrated in the 2<sup>nd</sup> Squadron motor pool and wash rack area. Between July 14-23, an EOD detachment and a company of Combat Engineers cleared approximately 1/3 of the 2<sup>nd</sup> Squadron motor pool. While the area with the heaviest concentration of DU—the burned M1A1s—was cleaned up by AMCCOM and CECOM personnel, the surrounding motor pool pads may have contained residual DU. In addition, many exposed or "spent" DU penetrators were scattered and in some cases partially burned in and around the MILVANS or conex containers.<sup>111</sup> As sections of the concrete pad were cleared of unexploded ordnance and DU, regular troops were brought in to do a final clean-up using brooms and other hand tools. These soldiers could have inhaled or ingested residual DU stirred up by sweeping, and could also have picked up DU fragments.<sup>112</sup>

A more comprehensive discussion of the Camp Doha Explosion and fires and the clean-up and recovery operations can be found in Tab I.

### **D. Level III Participants.**

This group comprises "all others." It includes soldiers downwind of burning DU-contaminated equipment, exposed to smoke or resuspended particles from burning or burned (oxidized) DU, and personnel who entered DU-contaminated Iraqi equipment. It also includes personnel who were present at Camp Doha during and after the motor pool fire, but who did not take part in cleaning operations in the North Compound. Based on existing research, this entire group probably received minimal exposures.

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<sup>111</sup> Lead Sheet # 6653, Interview of former Contracting Officer's Representative overseeing final cleaning and clearing at Doha, October 29, 1997, para 3, p. 3.

<sup>112</sup> Lead Sheet # 15493, Memorandum for Office of the Special Assistant for Gulf War Illnesses from former 11<sup>th</sup> ACR Engineer Officer, subject: "Summary of Personal Involvement and Observations Concerning Depleted Uranium at Camp Doha, Kuwait, 11 July -25 August 1991," March 16, 1998, p. 3-4.

## **1. Camp Doha**

This group consists of individuals who were at Camp Doha during the fire and subsequent cleanup activities, but were not directly involved in the sweeping operations or with picking up spent DU penetrators, fragments, or oxides in the North Compound. Individuals in the North Compound when the fire and initial explosions started are also included in this group. An M992 ammunition carrier loaded with non-DU 155mm shells burned for approximately 30 minutes before the explosions started, giving most soldiers time to evacuate the area. Cleanup activities in the South Compound are included in Level III because all of the known DU contaminant remained in the North Compound, except for a number of penetrators transported to an off-base trash dump.

## **2. Tank Fires**

During Operation Desert Storm/Desert Shield (ODS/DS), three accidental tank fires caused onboard DU munitions to "cook off" (detonate). In addition, a large shaped charge weapon, most likely a Hellfire missile fired from an Army Apache helicopter, struck an Abrams, setting it on fire. In all of these incidents, the crews escaped without injury. Some individuals, however, may have been exposed to DU aerosols from these fires, or to DU oxides or residues stirred up during clean up or equipment salvage operations. Individuals who were potentially exposed to fumes from the fires and related incidental contact with DU are included in this category. Those who performed cleanup, equipment processing, and similar activities are included in the appropriate categories of Level II. TAB J contains an incident-by-incident account reflecting our current knowledge of these incidents.

## **3. Entering DU-contaminated Iraqi or Coalition Equipment.**

This is believed to be one of the largest groups of people potentially exposed to DU. US troops often entered destroyed Iraqi armor out of curiosity or to collect souvenirs, despite express warnings against this practice from AMCCOM and other environmental health agencies. The 7<sup>th</sup> Corps Deployment After Action Report said:

War trophy hunting became a problem. Many soldiers and leaders did not recognize the hazards in war trophy hunting. Booby traps, radiation [*sic, i.e., radioactive*] contamination from depleted uranium, and unexploded ordnance combined to make this practice dangerous. In addition, units wanted to take home pieces of enemy equipment. This equipment can have gauges and other items that contain radium-226. We also found some Iraqi tanks with asbestos blankets. We never thought we would have to worry about the occupational health considerations of enemy equipment.<sup>113</sup>

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<sup>113</sup> "VII<sup>th</sup> Corps Deployment After Action Report, Defense of Northern Kuwait," (Undated), p. 11.

A March 11, 1991 message stipulating the Army requirements for captured Iraqi vehicles warned that "many of these captured vehicles pose a radiation hazard, either because devices on the vehicles do not meet US safety standards, or because of damage or destruction by depleted uranium munitions."<sup>114</sup>

Many soldiers had legitimate operational requirements to enter Iraqi equipment, such as checking for survivors, completing the destruction of the vehicles, or looking for items of intelligence value. Exposures of individuals searching enemy equipment would depend on their activity level inside the vehicle (how much dust they stirred up), as well as the time spent inside the vehicle.

Radioactive items in various foreign vehicles are typically sealed sources contained in chemical agent detectors, radiation monitors, and radiation instrument sources. Instrument dials painted with luminous paints containing radium, tritium, or promethium are noted exceptions to this rule. However, these radioactive materials are normally in very small quantities and would not present a hazard unless the source was damaged. Examples of radioactive sources in Iraq's Soviet-made equipment include the following.<sup>115</sup>

- Chemical Agent Detector found on T-72 tank, BMP infantry fighting vehicle, and BTR-series wheeled armored personnel carrier, - Plutonium-239 (185 to 260µg)
- Various instrument dials and switches designed to glow in the dark - Radium 226, tritium, and promethium 147.
- The case of the RWA 72K Radiation Warning and Detection Kit has a cesium 137 source on one of the straps (5.9 µCi).

#### **4. Exposure to Smoke from Equipment Struck by DU.**

US personnel often operated in close proximity to burning enemy equipment knocked out by DU rounds. These exposures could be fleeting, such as driving past burning wrecks, or longer-term, such as extended operations near sites where multiple enemy vehicles had been set afire by DU rounds. A large number of US troops fall into this category.

#### **E. Other Activities under Investigation But Not Yet Categorized.**

The Office of the Special Assistant is often contacted by veterans who wish to report incidents that they believe could have exposed them to DU contamination. The incidents they describe are often relatively isolated or unique events, and the available information is incomplete or unsubstantiated. Each of these reports is investigated and analyzed, but in the following cases the Office of the Special Assistant does not have enough information to conclusively determine

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<sup>114</sup> Message to ARCENT, Subject: Army Requirements for Captured Iraqi Materiel, March 11, 1991.

<sup>115</sup> Identification Guide for Radioactive Sources in Foreign Material, AST-1500Z-100-93, US Army Foreign Science and Technology Center, Charlottesville, VA, March 1993.

that DU exposures did or did not occur. Hence, they remain uncategorized and under investigation. The following cases fit this description.

## 1. Welders

Several members of the Alabama-based 900th Maintenance Company, Army National Guard, deployed to the Saudi port of Dammam to support an upgrade program for M1 tanks. This refit operation was implemented to bring earlier-model M1-series tanks to a more survivable M1A1 standard. Part of the upgrade involved welding armor panels (approximately an inch thick) to the frontal turret armor of the Abrams tanks. Some of the welders involved in the refit operations told OSAGWI investigators that they had been told the armor panels were DU.<sup>116,117,118</sup> In addition, two former members of a New Equipment Training Team offered similar accounts, with one saying that he had seen radiation warning symbols on the panels, which he described as machined, solid slabs of DU that were much heavier than steel.<sup>119,120</sup>

Other personnel, including fellow welders and senior personnel involved in the refit program, have contradicted these accounts. The Program Manager for Ground Systems Integration in Warren, Michigan, indicates that he had no knowledge of any such activity.<sup>121</sup> A retired Colonel, interviewed on August 7, 1997, stated that there were a few dozen workers welding ¾ inch RHS plates on the left and right glacis (the part of the turret to the right and left of the main gun) of M1 tanks in Dammam. He also said that he was involved in ordering the plates and knows they were not DU.<sup>122</sup> The production manager at Dammam likewise insists that the plates were RHS. He says that the RHS plates were shipped to him directly from the contractor by airfreight.<sup>123</sup> Fellow welders and unit members who worked alongside the individuals reporting the panels as DU recalled the add-on armor being either steel or titanium. The belief that the panels were DU may have originated with informal remarks by civilian co-workers that the M1A1 tanks contained DU armor (factory-sealed inside the turret armor, not retrofitted later). A welding supervisor noted that when he and other welders were preparing to leave the Gulf Theater in March 1991, they were told their medical records would be annotated to reflect the fact that they had worked around depleted uranium armor.<sup>124,125,126</sup> This may have contributed to the belief that the add-on armor was DU. A metallurgist who participated in research and development efforts that led to the decision to put additional armor protection on the front glacis of some of the Abrams vehicles recalled that the Abram's manufacturer, General Dynamics, had

<sup>116</sup> Lead Sheet # 17782, Interview of former 900<sup>th</sup> Maintenance Co. E-7, July 6, 1998.

<sup>117</sup> Lead Sheet # 17792, Interview of former 900<sup>th</sup> Maintenance Co. E-5, July 6, 1998.

<sup>118</sup> Lead Sheet # 17817, Interview of former 900<sup>th</sup> Maintenance Co. E-6, July 6, 1998.

<sup>119</sup> Lead Sheet #5737, Interview of former New Equipment Training Team E-7, July 24, 1997.

<sup>120</sup> Lead Sheet #5738, Interview of former New Equipment Training Team E-6, July 24, 1997.

<sup>121</sup> Lead Sheet #5979, Interview of the Program Manager for Ground Systems Integration at Warren, MI July 9, 1997.

<sup>122</sup> Lead Sheet #5679, Interview of former Colonel involved in Friendly Fire investigations, August 7, 1997, p. 2.

<sup>123</sup> Lead Sheet #5697, Interview of production manager of Dammam welding operation, August 14, 1997, p. 1.

<sup>124</sup> Lead Sheet # 14141, Interview of New Equipment Training Team E-6, January 14, 1998.

<sup>125</sup> Lead Sheet # 17784, Interview of former 900<sup>th</sup> Maintenance Co. Section Chief, July 6, 1998.

<sup>126</sup> Lead Sheet # 17789, Interview of former 900<sup>th</sup> Maintenance Co. E-5, July 6, 1998.

fabricated the armor from steel plate. Asked to comment on the feasibility of welding the pyrophoric DU onto regular armor, he said, "Metallurgically, welding a uranium plate to steel would be a disaster." After giving a technical explanation for his remark, he concluded: "Bottom line is that no welding engineer, metallurgist, vehicle designer, or armor designer would ever want a DU plate welded to the vehicle."<sup>127</sup> Although this allegation remains under investigation, the initial assessment is that DU was not involved.

## 2. Reported Ammo Truck Explosion

A veteran reported seeing a US ammunition truck explode in the area of the 1<sup>st</sup> Infantry Division on the third or fourth day of the ground war. The incident reportedly occurred about 75 to 100 miles northwest of Hafar Al Batin and was witnessed from a distance of 1 to 2 kilometers. According to the veteran, a mixed load of high explosive and DU rounds exploded. He reported finding blue sheaths on the ground which he believed (erroneously) to be characteristic of DU rounds.<sup>128</sup>

Other soldiers in the platoon also recall the incident but thought the vehicle was carrying artillery rounds<sup>129</sup> or powder bags for 155mm artillery rounds.<sup>130</sup> The veteran's platoon leader remembers hearing that the vehicle's brakes caught on fire and the driver, unable to extinguish the flames, drove the truck off Main Supply Route (MSR) Blue into the desert to reduce the hazard to other soldiers. After the explosion there was nothing left but the engine block.<sup>131</sup> A munitions expert at Picatinny Arsenal stated that the color blue is not indicative of DU munitions, but rather is associated with training rounds.<sup>132</sup>

The theater ammunition officer was unaware of any truckload of DU, which blew up during the war. He is fairly certain he would have heard of it if it had happened.<sup>133</sup> Civilian ammunition experts<sup>134</sup> in theater, including one from the 2<sup>nd</sup> Corps Support Command, that was responsible for transportation in the area, had no knowledge of a load of DU munitions exploding.<sup>135</sup> An officer commanding an ordnance storage area in the vicinity of the explosion recalled seeing the explosion at around 3 AM. He later heard that a truck's brakes had gotten stuck and caught on

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<sup>127</sup> Electronic Mail from Metallurgist involved in M1 upgrade R&D efforts, subj.: Welding Uranium, July 8, 1998.

<sup>128</sup> CMAT Report # 1997261-0000022, Interview of combat engineer from 61<sup>st</sup> Combat Support Detachment, October 16, 1997.

<sup>129</sup> Lead Sheet 7013, Interview of former platoon leader in 61<sup>st</sup> Combat Support Detachment November 14, 1997.

<sup>130</sup> Lead Sheet 7092, Interview of radio telephone operator from 61<sup>st</sup> Combat Support Detachment, November 18, 1997.

<sup>131</sup> Lead Sheet 7013, Interview of former platoon leader in 61<sup>st</sup> Combat Support Detachment November 14, 1997.

<sup>132</sup> Lead Sheet 14251, Interview of munitions expert from Picatinny Arsenal, January 26, 1998.

<sup>133</sup> Lead Sheet 6892, Interview of theater ammunition officer, November 6, 1997.

<sup>134</sup> These Quality Assistance Specialists Ammunition Specialists (QUASAS) were experts in the storage and transportation of ammunition.

<sup>135</sup> Lead Sheet 6991, Interview of the head QUASAS in theater, November 12, 1997; Lead Sheet 6996, Interview of the 2<sup>nd</sup> COSCOM QUASAS, November 12, 1997.



fire and caused a trailer load of artillery rounds to explode.<sup>136</sup> The former battalion commander of the 101st Ordnance Battalion confirmed this story.<sup>137</sup>

Information regarding this incident is still being sought.

### 3. Airmen Responding to A-10 Crash.

An A-10 aircraft reportedly crashed and burned while trying to recover at KKMC.<sup>138</sup> The crash could have exposed emergency response personnel (firefighters, security policemen, rescue personnel) to smoke and DU oxides from burning 30mm DU rounds carried as part of the A-10's combat ammunition load. In addition, clean-up crews might have been exposed as well, if they did not wear proper personal protective equipment. This case is under investigation.

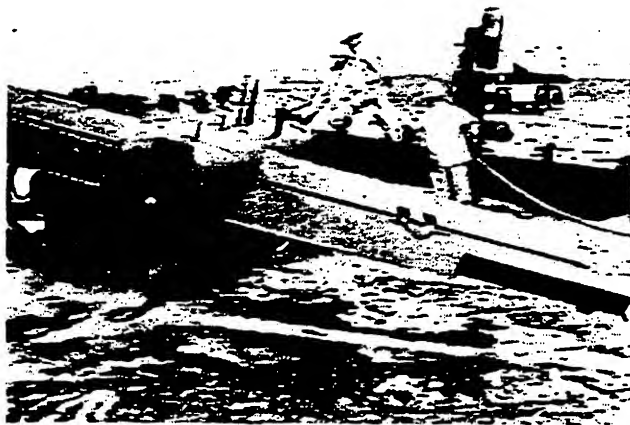


Figure 23 – Crashed A-10 at KKMC

### 4. “Hot gun” response for A-10 Aircraft

30mm DU rounds sometimes misfired in the A-10's GAU-8 cannon. These “hangfires” would have to be cleared and removed from the gun barrel, potentially exposing ground crews to airborne DU.<sup>139</sup> This office is still investigating these incidents.

<sup>136</sup> Lead Sheet 7072, Interview of commander of ordnance storage area, November 17, 1997.

<sup>137</sup> Lead Sheet 7155, Interview of commander of 101<sup>st</sup> Ordnance Battalion, November 25, 1997.

<sup>138</sup> CMAT No. 1998085-5, Callback Interview of USAF bomb disposal specialist, March 27, 1998.

<sup>139</sup> CMAT No. 1997190-1045, Callback Interview of USAF munitions specialist, August 19, 1997.

## *Tab H - Friendly Fire Incident Descriptions*

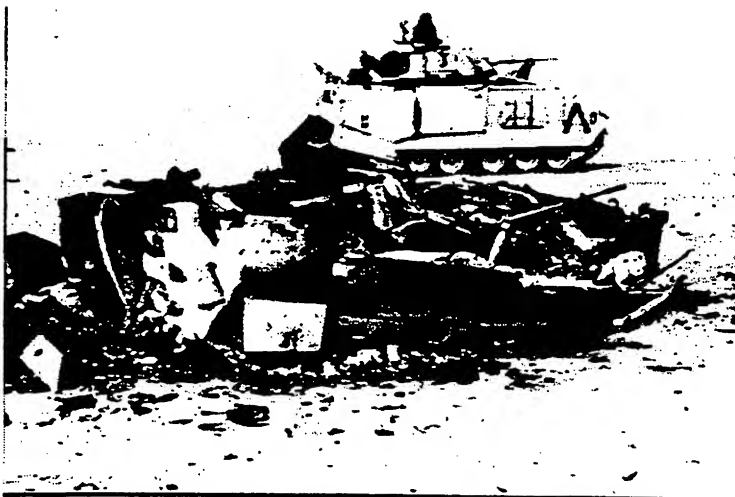


Figure 24 - Bradley passes destroyed Iraqi BMP-2 AFV

The “100 hour” Desert Storm ground campaign illustrated the ferocity and high operational tempo of modern warfare. Almost one million coalition combatants and over ten thousand armored vehicles engaged in intense and sustained combat operations around the clock and in all weather. Unlike previous conflicts where the front lines remained relatively fixed, Operation Desert Storm was characterized by a dynamic, often confused battlefield where individual combat vehicle crews and units, caught up in the rapid advance punctuated by pitched skirmishes and

battles, sometimes lacked “situational awareness” regarding the precise whereabouts of surrounding enemy and friendly forces.

On the modern battlefield, success tends to favor the side that can see, engage, and neutralize the enemy first. US combat vehicles enjoyed important technological advantages over Iraq’s older, mostly Russian-designed armored vehicles. Superior sighting and sensor equipment almost invariably allowed US crewmen to see and engage the Iraqis first, especially during night combat or in bad weather. US cannon systems were stabilized, so they could fire accurately while on the move. They could select, load, and fire munitions far more rapidly than their Iraqi counterparts. Finally, the use of DU rounds allowed US tanks to engage the enemy with unprecedented range and effect. While Iraqi Republican Guard T-72s—Saddam’s most formidable armored threat—boasted a 125mm cannon with a maximum effective range of 1,800 meters, US M1A1 tanks routinely scored kills at twice that distance.<sup>140</sup> In addition, Iraqi tanks, anti-tank guided missiles, and infantry anti-tank weapons failed to penetrate the DU armor of any of the 594 Heavy Armor M1A1s that saw action in the Gulf War, even when firing from well within their supposed “lethal” engagement parameters and scoring direct hits.<sup>141</sup> The result was one of the most lopsided victories in modern military history—Iraq lost in excess of 4,000 armored vehicles to US air and ground fire, while US ground forces sustained fewer than 25 combat vehicle losses from hostile fire.

<sup>140</sup> Atkinson, Rick. *Crusade: The Untold Story of the Persian Gulf War*. New York, NY: Houghton Mifflin, 1993, p. 466.

<sup>141</sup> *Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report*. Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 76.

Tragically, “fog of war” situations caused by the rapid advance of American forces, coupled with the use of long-range, highly lethal weapons, led to a number of friendly fire incidents in which US combat vehicles, usually M1A1 tanks, fired on fellow US combat vehicles or units. At least eight friendly fire incidents involving DU munitions occurred during the Gulf War. These incidents resulted in the contamination of six M1 or M1A1 tanks, and 15 Bradley Fighting Vehicles. Another M1A1 was hit by a large shaped-charge round, believed to be a Hellfire anti-armor missile fired from an Apache helicopter, that ignited an on-board fire. This incident is described separately in the “Tank Fires” section. The major contributing factors in all of these incidents were darkness or low visibility from heavy rains, sandstorms, etc.. In most cases, owing to battlefield confusion, the soldiers manning the targeted vehicles initially believed that the Iraqis had fired the shots that penetrated their armor. A team of battle damage assessment experts was later able to ascertain which vehicles had been engaged by Abrams tanks, since the DU round leaves a distinctive radioactive trace on the entrance and exit holes. In most cases, after-action investigations and word-of-mouth reporting among and between the units involved resulted in the affected soldiers learning that they had been victims of friendly fire. Not all of these soldiers, however, were aware of the potential health effects associated with internalized DU. Accordingly, the investigation of friendly fire incidents is being accompanied by a comprehensive effort to identify, locate, and contact all surviving soldiers who were in or on vehicles at the time they were penetrated by DU rounds.

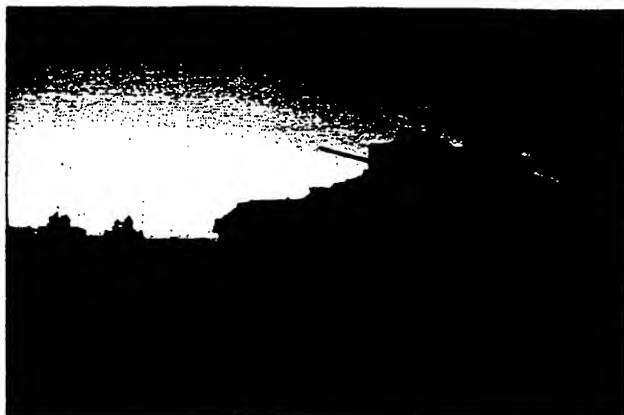


Figure 25 –Bradley patrol at dusk

**a. The 4<sup>th</sup> Squadron of the 7<sup>th</sup> Cavalry Regiment: Between 3 and 5:30 PM, February 26, 1991**

Three Bradleys configured as Cavalry Fighting Vehicles (CFVs) were struck by DU rounds fired from Abrams tanks between 3:00 and 5:30 PM on February 26. The vehicles were hit during a large-scale tank battle. Visibility was poor due to dusk and blowing sand and smoke.<sup>142</sup> The vehicles were either mistaken for Iraqi vehicles or caught in the crossfire of a “nonlinear” (shifting and confused) battlefield.<sup>143</sup>

At the time of the incident, the 3<sup>rd</sup> Armored Division was attacking to the east with the 1<sup>st</sup> Brigade on the right and the 2<sup>nd</sup> Brigade on the left, with the 3<sup>rd</sup> Brigade following. The 4-7<sup>th</sup> Cavalry was protecting the Division’s right flank. Alpha troop of the 4-7<sup>th</sup> Cavalry was

<sup>142</sup> Memorandum for the Commanding General, 3<sup>rd</sup> Armored Division, Subject: Investigation of the Circumstances Surrounding the Combat Damage to Alpha Troop 4-7 CAV, March 14, 1991.

<sup>143</sup> Memorandum for Commanding General, VII Corps, Subject: Investigation of Possible Fratricide by 3<sup>rd</sup> Armored Division Units, March 16, 1991.

screening on line with the lead elements of the 1<sup>st</sup> Brigade. Alpha troop was arrayed with the 3<sup>rd</sup> platoon on line, followed by the 2<sup>nd</sup> platoon on line 500 meters behind. Upon contact with six enemy tanks and 18 light armored vehicles (BMPs), the 2<sup>nd</sup> platoon split and sent three of its Bradleys to the right and left flanks of the 3<sup>rd</sup> platoon. The Bradleys of Alpha Troop were exchanging direct fire with the enemy tanks and BMPs at ranges from about 100 to 800 meters. The Bradleys employed their 25mm HEI (High Explosive Incendiary) and tungsten armor piercing (AP) munitions, as well as Tube-launched, Optically-tracked, Wire-guided (TOW) antitank missile systems. The following information is known about each Bradley (Cavalry Fighting Vehicle configurations) hit by DU rounds during the confused engagement.<sup>144</sup>

A Troop 4-7<sup>th</sup> Cavalry, Bradley (Bumper # A-24): A-24 was the first Bradley to be hit, struck by a 120mm DU sabot round fired from an Abrams tank.<sup>145</sup> At sundown, with wind-blown sand further reducing visibility, 3<sup>rd</sup> Platoon, to which A-24 was assigned, came over a rise in the terrain and saw a "target rich environment" with enemy ground troops and BMP armored fighting vehicles. A-24 engaged the enemy with TOW missiles and fire from their 25mm turret gun. When the gun jammed, the "track" commander attempted to pull the Bradley out of the fight to fix the gun and reload the top-mounted TOW missile launcher. As the loader was half-in, half-out of the vehicle attempting to reload the TOW, the vehicle was struck by a single DU sabot round and almost immediately was engulfed in flames. The DU sabot round entered the left front center of the turret section and exited the right rear center. The gunner was killed, and the vehicle commander received a serious leg wound. Two of the three remaining crewmen had minor injuries (flash burns); the third was unwounded, but reentered the Bradley to remove personal equipment and to recover the body of the gunner. Another Bradley, A-26, came to their aid, but apparently did not enter A-24.

A Troop 4-7<sup>th</sup> Cavalry, Bradley (Bumper # A-31): This Bradley, one of four in the 3<sup>rd</sup> Platoon, was part of the lead element to go into battle. After a heavy machine gun bullet that struck its transmission disabled BFV A-36, its crew was ordered to abandon the vehicle. As they were exiting through the hatches, the Bradley was struck again by a shell that the crew believes was fired from a T-72. The round "exploded" against the side of the Bradley, in the words of one crewman, wounding several of the evacuating soldiers. Shortly afterwards, BFV A-31 pulled alongside and picked up its crew. Minutes later, two 120mm DU sabots<sup>146</sup> struck A-31 in the right hull under the turret, exiting the left hull behind the driver's seat. Seven of the eight soldiers onboard were wounded, with some suffering severe burns and/or fragment wounds. During and after the battle, combat lifesavers were on the scene to extract the wounded from the damaged but still operable vehicle. Approximately 30 minutes after the battle had ended, the

<sup>144</sup> Battle scenario and damage information were taken from Memorandum for the Commanding General, 3<sup>rd</sup> Armored Division, Subject: Investigation of the Circumstances Surrounding the Combat Damage to Alpha Troop 4-7 CAV, March 14, 1991.

<sup>145</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 352.

<sup>146</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 371.

Platoon Sergeant and his observer, who had earlier gone into the two BFVs to help the wounded, returned to the scene and retrieved A-31, driving it back to their base camp.<sup>147</sup> All of the wounded survived, and the DU follow-up program in Baltimore is currently monitoring those with embedded fragments.

A Troop 4-7<sup>th</sup> Cavalry, Bradley (Bumper # A-22): This Bradley was the last vehicle hit by friendly fire in this battle. It was oriented east and the DU round<sup>148</sup> entered the left rear turret section and exited the right front turret. The gunner was killed, and three other soldiers (the commander and two dismount troops) received fragment wounds, including a Sergeant First Class (SFC) who was on top of the vehicle and was blown clear.<sup>149</sup> Two other soldiers entered the vehicle after it was hit to rescue the surviving crewmen. The BFV could still be driven, but was not combat-capable. Within hours of the incident, soldiers entered A-22 to salvage its radio, munitions, and other sensitive equipment, which were reused within the battalion. The SFC who was ejected from the vehicle has stated that it was common knowledge within the unit that A-22 had been struck by friendly fire; however, the SFC, at least, was unaware that DU munitions were involved. The SFC is currently enrolled in the Baltimore DU follow-up treatment program for soldiers exposed to DU.<sup>150, 151</sup>

Fifteen or more soldiers may have been exposed to DU dust since they were in these three Bradleys at the time the vehicles were struck by DU rounds. A Headquarters and Headquarters Troop (HHT) M113 medical ambulance evacuated the wounded soldiers to the Squadron Aid Station by at least three medics.<sup>152</sup> Additionally, an unknown number of soldiers may have been exposed when they entered the vehicles shortly after the vehicles were hit.

#### **b. Task Force 1-37 Armor: Evening of February 26, 1991**

At around 8:00 PM on February 26<sup>th</sup>, Task Force 1-37 Armor conducted a night attack on an Iraqi position defended by portions of the Talwakana Division, Republican Guard, equipped with T-72 tanks and BMPs. The attack was part of a coordinated division attack, with 1-37 Armor being the southernmost task force. 1-37 Armor was connected with the 3<sup>rd</sup> Armored Division in 7<sup>th</sup> Corps' attack in the south. One tank, bumper #B-23, was hit by a shaped charge weapon

<sup>147</sup> CMAT No. 1997289-234, Callback Interview of platoon sergeant of 3<sup>rd</sup> platoon, A troop, 4/7<sup>th</sup> Cavalry, October 14, 1997.

<sup>148</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 361.

<sup>149</sup> Battle scenario and damage information were taken from Memorandum for the Commanding General, 3<sup>rd</sup> Armored Division, Subject: Investigation of the Circumstances Surrounding the Combat Damage to Alpha Troop 4-7 CAV, March 14, 1991.

<sup>150</sup> CMAT No. 1997293-074, Callback Interview of A-22 Bradley commander, A troop, 4/7<sup>th</sup> Cavalry, October 20, 1997.

<sup>151</sup> Chandler, Jr., Captain E. Allen. Historical Report Format: "A Troop, 4/7<sup>th</sup> Cavalry, Contact with Iraqi Tanks, February 26, 1991." Fort Leavenworth, KS: Center for Army Lessons Learned, Gulf War Collection, SSG AAR4-147, May 29, 1991.

<sup>152</sup> "USAAVNC Army Aviation in Desert Shield-Storm 13, Recon and Security" (Fort Leavenworth, KS: Center for Army Lessons Learned, Operations Desert Shield - Desert Storm - Gulf War, 1990-1991, p. 307.

(most likely a Hellfire missile), causing an on-board fire. This incident is described in the section on tank fires. At the time of the attack, low, heavy clouds and rain obscured visibility. The following information is known about the tank (Bumper # C-12) hit by a DU round.

C Co., Task Force 1-37 Armor, Abrams Tank (Bumper # C-12): This tank was struck in the rear by a 120mm DU round<sup>153</sup> which caused a loss of power. As the crew was evacuating, an antitank (AT) missile struck the rear of the bustle rack, causing the rucksacks, duffel bags, and associated equipment fastened there to catch fire. There was no damage to the turret's interior, and no secondary explosions of stored ammunition or fuel. No injuries were reported among the crewmembers, and the tank was recovered on March 4, 1991. The identities of the crewmembers are unknown at this time. It is assumed that the tank had its normal four-man crew.<sup>154</sup>

### **c. Battle of Norfolk: Early Morning Hours of February 27, 1991**

The largest friendly fire incident of the war involved the soldiers of the 3<sup>rd</sup> Brigade of the 2<sup>nd</sup> Armored Division (Fwd) during a February 27, 1991 night attack on the 37<sup>th</sup> Brigade of the Iraqi 12<sup>th</sup> Armored Division. This 2<sup>nd</sup> AD brigade was brought in from Germany to form the 3<sup>rd</sup> Brigade of the 1<sup>st</sup> Infantry Division in Operation Desert Storm. The tank battle that ensued was a tumultuous, 360-degree action. Overcast skies and wind-driven rain and smoke compounded the confusion of the pre-dawn, swirling battlefield. The US combat vehicles were using thermal sights, making identification of friend or foe more challenging. The battle resulted in the damage or destruction of five Bradleys and five Abrams Tanks, with nine of the ten US vehicles hit directly by 120mm DU sabots fired from M1 tanks. In addition, several of these vehicles were also struck by enemy fire.<sup>155</sup>

The action began following the Battle of 73 Easting in which the 2<sup>nd</sup> Armored Cavalry Regiment (ACR) located and destroyed elements of the Iraqi 12<sup>th</sup> Armored Division and the Tawalkana Division. The 2<sup>nd</sup> ACR halted their advance and allowed the two brigades of the 1<sup>st</sup> Infantry Division (ID) to pass through their positions on the night of February 26<sup>th</sup>. Most units do not train in peacetime to do a night passage of lines (while firing live ammunition) because it is considered too hazardous. Despite the fact that many of the soldiers had had little or no sleep in the previous 36 hours, the passage of lines was performed flawlessly. Following the passage, the two brigades were attacking east as part of a division coordinated attack with the 1<sup>st</sup> Brigade in the north and the 3<sup>rd</sup> Brigade in the south. Since there were no obvious terrain features to separate the forces, the dividing line between brigade sectors was the 92 East/West grid line.

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<sup>153</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 162.

<sup>154</sup> Battle scenario and damage information were taken from "Analysis of 1-37 Armor's Battle Damage Incident," Aberdeen Proving Ground, MD: Ballistic Research Laboratory, (Undated).

<sup>155</sup> All battle scenario and damage information for the Battle of Norfolk (except as otherwise noted) was taken from: Memorandum for the Commanding General, 1<sup>st</sup> Infantry Division, Subject: "Informal Investigation of the Night Attack Conducted by 3<sup>rd</sup> Brigade on February 26-27, 1991," March 10, 1991.

The Third Brigade attacked with three battalions on line to clear the zone of the enemy. Although the night was clear, with plenty of starlight to optimize the performance of night vision devices, the battlefield was far from ordered. In spite of its leaders' best efforts, the battalions of the 3<sup>rd</sup> Brigade did not maintain a line-abreast formation. To further complicate matters, pockets of enemy infantry became interspersed among the attacking US combat vehicles. The shifting battlefield contributed greatly to the ensuing confusion. Two Bradleys of Bravo Company, Task Force 1-41 Infantry were the first to be engaged. Equipment problems forced the company commander to switch vehicles and the company momentarily lost contact with the rest of the battalion. In their effort to reestablish contact, Bravo Company entered an Iraqi bunker complex and was engaged by rocket propelled grenades (RPGs) at around 2:00 AM on February 27<sup>th</sup>. Following the initial RPG attacks, Bravo Company was fired on by US Abrams tanks. Here is what is known about the three Bradleys damaged in this action:

B Co. Task Force 1-41 Infantry, Bradley (Bumper # B-21): This Bradley was struck by two 120mm DU sabot rounds,<sup>156</sup> killing three soldiers and wounding at least three of the ten crewmen and infantry soldiers aboard. At least two of the wounded had embedded fragments; a third suffered severe burns in the incident.

B Co. Task Force 1-41 Infantry, Bradley (Bumper # B-26): This was the vehicle commandeered by the company commander after his Bradley malfunctioned. A 120mm sabot struck the Bradley,<sup>157</sup> killing one soldier. The crew from another BFV (#B-32) pulled up alongside B-26 and assisted its occupants in evacuating the vehicle. The same personnel also removed sensitive items of equipment from B-26. A Sergeant Major in B-32 who responded to the incident believes his exposure to DU was minimal, since he was only in the struck vehicle for a very short period of time.<sup>158</sup>

B Co. Task Force 1-41 Infantry, Bradley (Bumper # B-33): This Bradley was struck by a 120mm sabot round.<sup>159</sup> No soldiers were killed. It is unknown who, or how many, soldiers were onboard at the time it was struck, or the number and extent of injuries. Parts had been stripped from the vehicle after it was knocked out.

The numbers and identities of soldiers who entered the Bradleys to rescue fellow soldiers or for other reasons are currently unknown. Following the attack, the wounded were evacuated and

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<sup>156</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 136.

<sup>157</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 85.

<sup>158</sup> CMAT No. 1997294-006, Callback Interview of B-32 Bradley commander, B company, 1-41<sup>st</sup> Infantry, October 21, 1997.

<sup>159</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 145.

soldiers with combat lifesaving certification rendered first aid. Their efforts were hampered by enemy mortar fire, which fortunately did not produce additional casualties.

Later that morning, between 4:00 AM and 5:00 AM, two Bradleys from Delta Company, Task Force 1-41 Infantry came under a combination of friendly and enemy fire. The Bradleys had become separated from the rest of the battalion, initially because one of the Bradleys was stuck in a revetment (three-sided earthworks or berms built by the Iraqis to shelter their armor while allowing them to engage hostile forces). Later, the unit halted when they encountered surrendering Iraqi troops. They were ordered to point the Iraqis in the right direction and catch up with the rest of the company. Some time later they were engaged by Iraqi rocket-propelled grenades (RPGs), and returned fire. This drew the attention of soldiers from the 1-34<sup>th</sup> Armor who thought they were drawing fire. After receiving authorization to fire, the tanks destroyed the two Bradleys. A subsequent plotting of their location indicated that the Bradleys were about 1 km into the 1<sup>st</sup> Brigade's sector. A bunker complex with unfired RPGs was discovered approximately 300 meters to the front of the two Bradleys. The following is known about the two Bradleys damaged in this action:

D Co. Task Force 1-41 Infantry, Bradley (Bumper # D-21): After driving all night (until around 4:00 AM) this BFV, with at least seven occupants, drove into a bomb crater. In the process of extricating itself, D-21 became separated from the rest of the company. Shortly afterward, the BFV and its squad moved into a bunker area, where they rounded up about 20 Iraqi EPWs. At this point they were spotted and engaged by M1A1 tanks from another unit. D-21 was stuck in the side hull by three 120mm sabot rounds,<sup>160</sup> two of which passed through both sides of the vehicle and struck another BFV (D-26) parked 20 feet away. The driver of D-21 was killed; the other three soldiers still in the vehicle were wounded. The vehicle caught fire and was totally destroyed. A scout unit from the 1<sup>st</sup> Infantry Division that had also fired on the two BFVs, apparently without effect, realized its error and came to their aid, evacuating the wounded crewmen to a nearby medical aid station. No one attempted to remove anything from either D-21 or D-26, since the two BFVs were on fire when responding personnel arrived, and were too badly gutted to be salvageable. Several members of the crews or associated infantry fled into the desert after the second volley, fearing the vehicles would explode.<sup>161</sup>

D Co. Task Force 1-41 Infantry, Bradley (Bumper # D-26): This Bradley was struck by two 120mm sabot rounds<sup>162</sup> that had just passed through D-21, in the incident described above. The sole occupant of D-26, the driver, sustained severe leg wounds and other injuries from the projectiles. Seven other crewmen or "dismount infantry" (troops who ride the Bradley into the battle area, then "dismount" the vehicle to engage the enemy), had earlier left the BFV to secure

<sup>160</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 189.

<sup>161</sup> CMAT No. 1997289-197, Callback Interview of former SFC in D Company, 1-41<sup>st</sup> Infantry, October 16, 1997.

<sup>162</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 202.



enemy prisoners of war (EPWs) and to clear captured bunkers. The driver, though badly wounded, was able to get out of the vehicle on his own, and once outside was aided by fellow platoon members. After being struck, D-26 caught fire and "melted to the ground," in the words of its driver, making it unlikely that any troops would have entered it. Both D-21 and D-26 were left in place until after the ground war.<sup>163</sup>

The five tanks damaged or destroyed at the Battle of Norfolk were the last of the friendly fire victims to be engaged in this battle. These tanks, which were from 3-66 Armor, were attached to Task Force 1-41 for this mission. The first tank to be destroyed (B-66) was initially struck by an RPG. When an RPG strikes a tank, it produces a shower of flames and smoke. To soldiers viewing the event through thermal sights, it may appear as if the struck tank has fired in their direction. This may have been the case in this incident, because shortly after the RPG impact, B-66 came under fire from one or more tanks. Four additional tanks rushing to the aid of B-66 were subsequently fired on and struck as well. Here is what is known about the five Abrams tanks damaged in this action:

B Co. 3-66 Armor, Abrams (Bumper # B-66): This was the Bravo company commander's tank. It was hit by three 120mm DU rounds<sup>164</sup> with one striking just below the turret, killing the gunner. None of these rounds penetrated the DU armor panels. At the time it was hit, it was moving in a different direction than the rest of the company. This may have contributed to the misidentification. Three soldiers survived this attack, at least two of them with severe burns. One of the survivors had fragment wounds as well.

B Co. 3-66 Armor, Abrams (Bumper # B-22): This tank, reacting to the fire that engaged B-66, turned in the direction of fire and was hit on the front slope by a 120mm DU round.<sup>165</sup> There was no internal damage to this tank.<sup>166</sup> The driver was wounded. It is presumed that this tank had its full crew of four at the time it was struck.

A Co. 3-66 Armor, Abrams (Bumper # A-14): This tank was struck by a 120mm sabot round fired from an Abrams tank.<sup>167</sup> Three soldiers were wounded. It is presumed that this tank had its full crew of four when it was struck.

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<sup>163</sup> CMAT No. 1997295-004, Callback Interview of former Bradley driver in D Company, 1-41<sup>st</sup> Infantry, October 28, 1997.

<sup>164</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 116.

<sup>165</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 70.

<sup>166</sup> Memorandum for SRC, AMCCOM-SWA, Subject "Vehicle Assessment Report Depleted Uranium Contamination," May 14, 1991, p. 7, paragraph A.

<sup>167</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 95.

A Co. 3-66 Armor, Abrams (Bumper # A-31): This tank was struck in the left rear by pieces of a 120mm DU round.<sup>168</sup> A report prepared by the Radiation Control (RADCON) Team from KKMC states that the four-crew members of this tank all received fragment wounds and were evacuated back to Germany. The Company Commander, who relayed this information to the team in late April 1991, also stated that numerous individuals were exposed to smoke during the resulting fire. One member of the RADCON Team advised the Company Commander that all individuals involved in the DU incident should receive an appropriate medical exam. The commander was given a copy of a health hazard message dated April 11, 1991 and a copy of TB522<sup>169</sup>

A Co. 3-66 Armor, Abrams (Bumper # A-33): At approximately 4:30 AM on the morning of 27 February, A-33 was struck in the engine compartment by a TOW anti-tank guided missile probably fired from a Bradley Fighting Vehicle. The uninjured crew were evacuating their disabled tank when it was hit again, this time by two DU sabot rounds<sup>170</sup> that hit the vehicle in the left side and exited through its right side. The tank commander, driver, and gunner sustained injuries from fragments. The loader, who was already outside the tank, was apparently uninjured, but may have been at risk from inhaling DU aerosols created on impact. At least one of the individuals involved in this incident is enrolled in the VA's DU Follow Up Program.<sup>171</sup>

In summary, a total of 50 soldiers were exposed to DU fragment wounds and DU aerosols inhaled or ingested during the Battle of Norfolk. Additionally, an unknown number of soldiers could have been exposed to DU residues when they entered the vehicles shortly after the damage occurred.

#### **d. Battle for Jalibah Southeast Airfield: Around 6:00 AM, February 27, 1991**

On February 27<sup>th</sup> the 2<sup>nd</sup> Brigade of the 24<sup>th</sup> Infantry Division was attacking the heavily defended Jalibah Airfield, the last major obstacle between the 24<sup>th</sup> Infantry Division and the Euphrates River. Satellite imagery and reconnaissance aircraft indicated the presence of 20 enemy tanks and more than 1,000 dug-in Iraqi soldiers. Task Forces 1-64 Armor and 3-69 Armor were to "overwatch" (provide covering fire) from the southwest and southeast corners of the airfield respectively. A north-south road was to be the boundary between the two overwatching forces. Meanwhile, Task Force 3-15 Infantry was to sweep the airfield from west to east.

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<sup>168</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 77.

<sup>169</sup> Memorandum for SRC, AMCCOM-SWA, Subject "Vehicle Assessment Report Depleted Uranium Contamination," May 14, 1991, p. 10, paragraph J.

<sup>170</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 101.

<sup>171</sup> CMAT No. 1997280-031, Callback Interview of former A-33 tank commander, A Company, 3-66<sup>th</sup> Armor, October 23, 1997.

As the two overwatching task forces were moving into position, a platoon from the 3-69 Armor crossed to the west of the boundary road. At this point, Company C of 3-69 Armor came under direct and indirect fire from the Iraqis at the airfield. As the C Company tanks moved in on what they thought was an Iraqi defensive belt, Bradley vehicles from Task Force 1-15 Infantry appeared about 2,000 to 2,500 meters in front of them. The C Company tanks mistook the Bradleys for Iraqi armored vehicles and engaged them with eight to sixteen 120mm armored piercing (DU) rounds. The following is what is known about these Bradleys:<sup>172</sup>

C Co. 3-15 Infantry, Bradley (Bumper # C-11): In the early morning hours of February 27, BFV C-11 was on the right flank of a four-company task force formation closing in on Jalibah Southeast Airfield in southern Iraq. After changing direction to evade incoming enemy artillery, C-11 was hit from behind by a 120mm DU sabot round fired from an Abrams tank.<sup>173</sup> The round entered the Bradley through the ramp, passed through the troop compartment, and exited the left side of the vehicle. An antitank weapon (AT4) stowed inside the Bradley detonated, inflicting severe injuries to several personnel in addition to the wounds produced by DU fragments and shrapnel. A PFC was killed and at least five of the remaining seven personnel were injured, most seriously. Two NCOs aboard the stricken vehicle provided emergency first aid, then drove the damaged Bradley filled with wounded soldiers for about three miles to a medical aid station. They removed salvageable equipment from the shot-up BFV, then drove the still-serviceable vehicle back to their company's forward operating location. While en route they picked up two other soldiers from another disabled combat vehicle. The two NCOs continued to man C-11 for another three days before it was taken away from them and sent back to KKMC with other DU-contaminated systems.<sup>174</sup>

C Co. 3-15 Infantry, Bradley (Bumper # C-22): This Bradley was struck on the right side, just below the turret, by a 120mm sabot round.<sup>175</sup> The round exited the vehicle on the front left side after passing through the driver's compartment, killing the driver. Only one other soldier on this vehicle has been identified to date.

C Co. 3-15 Infantry, Bradley (Bumper # C-23): Two 120mm sabot rounds entered the vehicle<sup>176</sup> on the right side and crossed through the engine compartment, exiting on either side of the

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<sup>172</sup> Battle scenario and damage information (except where otherwise noted) were taken from: Memorandum from 3d Battalion, 15<sup>th</sup> Infantry to AC of S, G3, 24<sup>th</sup> ID, M FSGA, 32314. Subject: "Battle Damage Assessment" June 14, 1991.

<sup>173</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 319.

<sup>174</sup> CMAT No. 1997288-057, Callback Interview of former Bradley driver in C Company, 3-15<sup>th</sup> Infantry, October 23, 1997.

<sup>175</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 339.

<sup>176</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 328.

driver. Nine soldiers were probably in this Bradley, three of whom—all wounded—have been identified.

There could have been as many as 25 soldiers onboard the three Bradleys at the time they were struck at Jalibah. The number of soldiers who entered the contaminated vehicles to rescue fallen comrades is unknown at this time.

**e. 4-66<sup>th</sup> Armor: Around 4:30 PM, February 27, 1991**

On February 27<sup>th</sup> the scout platoon of 4-66<sup>th</sup> Armor was ordered to provide flank security and maintain contact with elements of 1-35<sup>th</sup> Armor on the battalion's left flank. The unit was attacking an Iraqi ammunition storage area. Light rain and dense smoke from a nearby burning ammunition dump obscured the visibility. The operation went smoothly until around 4:30 PM, when the advance of 1-35<sup>th</sup> Armor stalled, leaving the flanks of 4-66<sup>th</sup> Armor exposed. Within minutes, Bradleys from the scout platoon came under fire from dug-in Iraqi rocket propelled grenade teams. During the ensuing fight, two of the scout platoon's Bradleys were struck by DU rounds. The following is known about these Bradleys:

HQ Co. 4-66<sup>th</sup> Armor, Bradley (Bumper # HQ-55): This Bradley was hit by a 120mm DU sabot round on the lower right side, just above the road wheel.<sup>177</sup> All five soldiers onboard evacuated without injury and have been identified.

HQ Co. 4-66<sup>th</sup> Armor, Bradley (Bumper # HQ-54): This was the scout Platoon Sergeant's Bradley. To cover the evacuation of HQ-55, the Platoon Sergeant placed his track between the damaged Bradley and the enemy. He had just opened fire on the Iraqis when two DU rounds struck his Bradley, killing his driver and wounding the commander and gunner.<sup>178</sup>

**f. 1-34<sup>th</sup> Armor**

Just after midnight on February 27, the 1-34 Armor Battalion of the 1<sup>st</sup> Brigade, 1<sup>st</sup> Infantry Division, was doing a night passage of lines through the US 2<sup>nd</sup> Armored Cavalry Regiment. The 2<sup>nd</sup> ACR had been engaging the Republican Guard Tawalkana Division. An Abrams mistook the Bradley, which was stationary at the time, for an Iraqi combat vehicle and fired a single round from about 1,500 meters. The DU sabot went in the Bradley's left rear door on a centerline trajectory. The hit set off TOW missiles, 25mm rounds, and other munitions stored in HQ-232's interior. The blast ejected the driver and gunner through their respective hatches, which were open. They were extremely fortunate, escaping with only minor flash burns. The commander also escaped without injury. Two observers in the rear of the vehicle were wounded. One lost his heel (probably to the DU round itself, not the secondary explosion); the other suffered a serious leg injury. HQ-232 was completely destroyed. Another Bradley, HQ-231,

<sup>177</sup> Battle scenario and damage information were taken from Fratricide Assessment # 1-27: 4-66 Armor. Fort Leavenworth, KS: Center for Army Lessons Learned, Operation Desert Shield - Desert Storm - Gulf War, Undated.

<sup>178</sup> Fratricide Assessment # 1-22: 4-66 Armor. Fort Leavenworth, KS: Center for Army Lessons Learned, Operation Desert Shield - Desert Storm - Gulf War, Undated.

was hit by a 25mm (non-DU) round while moving forward to assist HQ-232. Other than the surviving crewmembers of HQ-232, no other personnel entered the vehicle.<sup>179,180</sup>

#### **g. 2<sup>nd</sup> Squadron of the Second Cavalry Regiment**

A friendly fire incident involving Bradley bumper # G-14 occurred on 27 February 1991. At approximately 4:00 PM local time a shell, type or source unknown, struck G-14 in the left rear. The round struck and penetrated the turret, killing the gunner. The four other crewmembers received only minor injuries, and were returned to duty later that evening. The round passed through the turret without igniting any secondary explosions or fires. Later, at approximately 10:00 PM, an M1A1 that was part of a US armored unit coming forward to relieve G Troop was apparently startled by the sudden appearance of G-14, and fired a 120mm DU round into the empty vehicle from an estimated range of 50 meters. The shell set off an onboard fire that completely destroyed G-14. The BFV melted, making it difficult to determine the number and type of shells that struck it, although at least one was assessed as DU by the BDAT team. Corroborating information is still being sought by this office.<sup>181, 182</sup>

#### **h. Air-to-Ground Incidents**

On January 22, 1991, US Air Force A-10 "Warthog" close air support aircraft mistakenly strafed the abandoned town of Hamel Pyat, just inside the Saudi border opposite southern Kuwait, while a patrol from the Marine 1<sup>st</sup> Force Reconnaissance Company was stopped at the location. The errant attack did not cause any casualties, since the 12-15 Marines who witnessed the incident were on the opposite end of the empty town. The A-10 involved in the incident made a single short strafing run from a very high altitude. Because of the threat from Iraqi surface-to-air missiles, A-10s had been ordered to stay at least 8,000 feet above ground level. The A-10 is most effective at lower altitudes, and the great firing distance caused a wide dispersion of the 30mm rounds. Although the cyclic (firing) rate of the A-10's Gatling gun is extremely high (6,000 rounds per minute), it typically fires a two-to-three second burst, meaning 200-300 shells might have impacted the target area. One shell in five is a non-DU tracer round. Fortunately, none of the Marines were close enough to the impacting DU rounds to be wounded or potentially exposed.<sup>183</sup>

On January 23, 1991, an A-10 inadvertently strafed a Marine observation post, also manned by 1<sup>st</sup> Marine Force Recon personnel, near the border town of Khafji, Saudi Arabia, abutting the eastern tip of Southern Kuwait. No casualties resulted. The squad-sized team had set up a

<sup>179</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 245.

<sup>180</sup> Lead Sheet # 16645, Interview of former 1-34 Bradley crewman, May 19, 1998, p. 1-2.

<sup>181</sup> Richard A. Koffinke, Jr. and Frederick T. Brown. US Army Battle Damage Assessment Operations in Operation Desert Storm, Vol. II (U) ARL-TR-104, Aberdeen Proving Ground, MD: Army Research Laboratory, March 1993, p. 349.

<sup>182</sup> Lead Sheet # 7178, Interview of former G Troop Commander, December 8, 1997.

<sup>183</sup> Lead Sheet # 14195, Interview of former Commander, Marine First Force Recon Company, January 19, 1998.

forward observation post, OP 8, to gather intelligence and targeting information on Iraqi forces across the border. OP 8 consisted of a reveted HUMVEE configured as a reconnaissance vehicle dug into a sand dune, manned by a squad of Marines and a smaller number of Navy SEALs. At dusk, the Marine forward air controller at OP 8 spotted an Iraqi artillery position two kilometers to his front, and requested an orbiting A-10 on an "armed reconnaissance" mission to attack the enemy position. The A-10 pilot misidentified OP 8 as his target, and fired a single burst of 30mm DU shells that impacted in and around the post. No Marines were injured in the incident, and no vehicles or equipment were struck. The soft surface, wide dispersion of the shells, and the distance from which they were fired would have reduced the likelihood of an aerosol-forming impact. The Marines remained at the site for at another day or so, but did not disturb the buried or exposed DU projectiles.<sup>184</sup>

A more serious incident, once again involving the Force Recon Company, occurred on January 24, 1991. A pair of A-10s working a "kill box" just over the Kuwaiti border targeted a Marine platoon that was driving east along a road that parallels a man-made anti-smuggling sand berm that runs the length of the southern Saudi-Kuwait border. At the time of the attack, the Marines were about 30 kilometers west of Khafji, Saudi Arabia, which had recently been the scene of the first large-scale ground clash between Coalition and Iraqi forces. The convoy, consisting of three five-ton trucks and a pair of HUMVEEs, was two kilometers inside the Saudi border, south of the Fire Support Coordination Line (FSCL) intended to protect forward US and Coalition forces from friendly air, ground, and naval firepower. Despite the fact that the vehicles were south of the berm delineating the FSCL, and that the noontime skies were bright and clear, the pair of A-10s made four strafing passes from an altitude of about 4,000 feet. While the first two passes missed by a wide margin, the third and fourth strafing runs knocked the wheel off a HUMVEE, peppered other vehicles with fragments, and caused two casualties.

A Marine corporal had a small shard of aluminum, apparently from the metal jacket of a 30mm DU projectile, puncture his forearm, while a Navy Chief serving as a corpsman had a very small metal fragment lodged in his wrist. In both cases, the fragments were completely removed. When the unit returned to the United States in May 1991, the medic who had treated both casualties referred the Navy Chief to a special Radiation Physical to verify that he had not been exposed to DU or was not carrying any residual DU.<sup>185</sup> Contacted for this investigation, the Chief (now retired) said that he had not undergone a Radiation Physical, but the fragment had been removed the day after the incident. A series of X-rays a year later (when he was getting a MRI examination) did not reveal any embedded fragments.<sup>186</sup>

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<sup>184</sup> Lead Sheet # 14145, Interview of former Marine Force Recon Captain, January 14, 1998.

<sup>185</sup> Lead Sheet # 14195, Interview of former Commander, Marine First Force Recon Company, January 19, 1998.

<sup>186</sup> Lead Sheet # 15421, Interview of former Navy SEAL Corpsman attached to Marine First Force Recon Company, March 10, 1998.

### **i. Ship-to-Ship Incident**

A ship-to-ship friendly fire incident involving the USS Jarrett (FFG-33) and the USS Missouri took place on February 25, 1991. Three US Navy warships and one UK Royal Navy warship (HMS Gloucester) were shelling Iraqi-occupied Faylakah Island. An incoming Silkworm anti-ship missile fired from a shore-based Iraqi missile launcher was destroyed by a Seadart missile fired from HMS Gloucester. During the engagement sequence, the USS Missouri fired off one or more chaff bundles (a standard countermeasure against radar-guided missiles). The Phalanx Close In Weapons System (CIWS) on the USS Jarrett, which was 2-3 miles off the Missouri's port side, experienced an anomaly that caused the system, which was operating in the "automatic engagement" mode, to fire a quick burst at the chaff. The former Executive Officer (XO) aboard the USS Missouri estimated that four of the 20mm rounds, which have not been confirmed as DU, struck the ship in the bulkhead above the famed "surrender deck" where the Imperial Japanese government had capitulated in 1945. All but one of the rounds bounced off the bulkhead, leaving dents, since their energy was mostly spent. One round penetrated the thin upper metal of the bulkhead and passed through a guest berth on the ship. No casualties resulted, and to the best of the XO's recollection, the round was not recovered and probably fell into the sea.<sup>187, 188</sup>

In summary, the total number of friendly fire exposures could involve numerous soldiers, including those who may have entered the contaminated systems soon after they were disabled by DU munitions. Based on standard manning configurations, we estimate that 113 soldiers were aboard the fifteen Bradleys and six Abrams at the time they were struck by DU munitions (see Table 6).

All of the DU friendly fire incidents reported from the Gulf War involved US systems firing on other US systems. No Coalition troops or equipment were targeted or struck by DU rounds fired from US or UK weapons.

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<sup>187</sup> Lead Sheet 14246, Interview of former USS Missouri Executive Officer, January 23, 1998.

<sup>188</sup> "Military Probes Friendly Fire Incidents" Washington, DC: Office of the Assistant Secretary of Defense, Public Affairs: News Release, August 13, 1991.

- **Background.**

### Figure 26- Camp Doha Location

On the morning of July 11, 1991, two of the 11<sup>th</sup> ACR's three combat formations, called squadrons, were field-deployed, leaving behind a single squadron (plus support elements) to serve as a guard force.<sup>193</sup> This squadron was parked in Camp Doha's North Compound, a fenced-off area comprising several motor pool pads, each the size of two or three football fields, as well as some administrative buildings and a wash rack (Figure 27).<sup>194</sup> Also located in the area was a compound where approximately 250 British soldiers, mainly from the Royal Anglian

<sup>189</sup> Lead Sheet 15358, Interview of former 11<sup>th</sup> ACR Commander, March 6, 1998, p. 2.

<sup>190</sup> US Army Safety Center, Army Accident Report 910711001, September 20, 1991, 18 July 1991 interview of Regimental Quartermaster S-4, p. 4.

<sup>191</sup> US Army Safety Center, Army Accident Report 910711001, September 20, 1991, 18 July 1991 interview of Regimental XO, p. 3.

AR 15-6 Report of Investigation, Fire/Explosion at Doha, Kuwait, 11 July 1991: Findings. July 27, 1991, p. 8.

193 Lead Sheet # 6473, Interview of former Echo Troop, 2/11<sup>th</sup> ACR NCO, October 20, 1997, p. 1.

<sup>194</sup> AR 15-6 Report of Investigation, Fire/Explosion at Doha, Kuwait, 11 July 1991: Findings. July 27, 1991, p. 1-2.



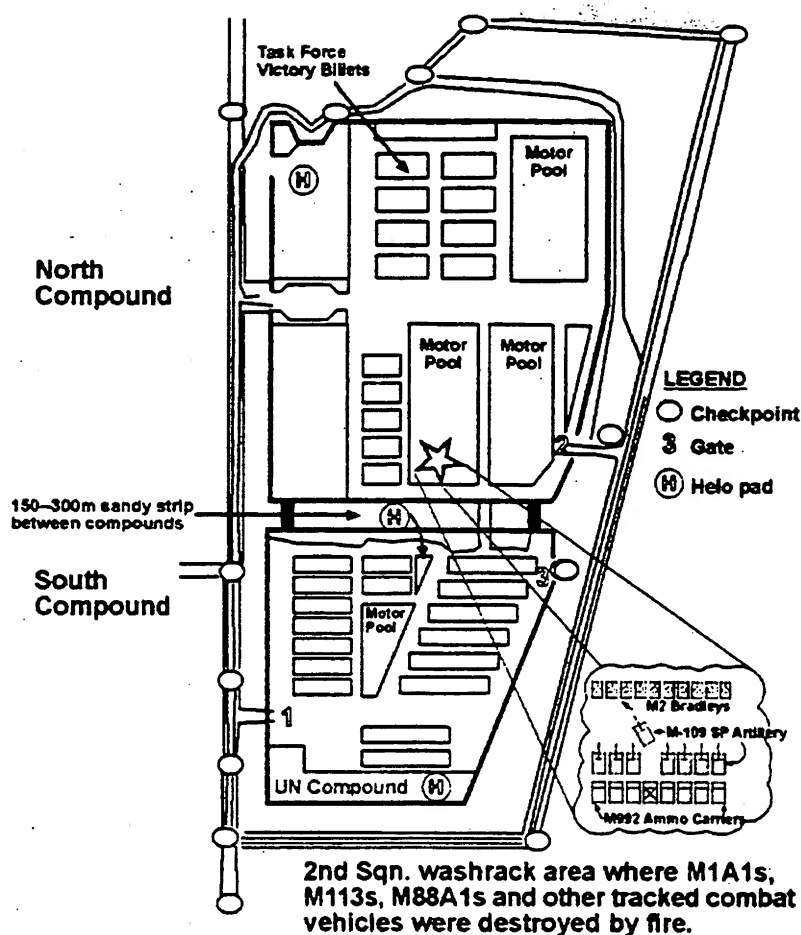


Figure 27 - Camp Doha Diagram

Regiment and Headquarters British Forces Middle East, were present on the morning of the fire.<sup>195</sup>

At approximately 10:20 A.M, a defective heater in a M992 ammunition carrier loaded with 155mm artillery shells caught on fire. Unit members tried unsuccessfully to extinguish the fire before being ordered to evacuate the North Compound. This evacuation was still underway when the burning M992 exploded at 11:00 AM, scattering artillery submunitions (bomblets) over nearby combat-loaded vehicles and ammunition stocks. This set off an hours-long series of blasts and fires that devastated the vehicles and equipment in the North Compound and scattered unexploded ordnance (UXOs) and debris over much of the

remainder of the camp.<sup>196</sup> The fires produced billowing black and white clouds of smoke that rose hundreds of feet into the air and drifted to the east-southeast, across portions of both the North and South Compounds, in the direction of Kuwait City.<sup>197</sup>

The fires had died down enough by mid-afternoon to allow a preliminary damage assessment. There were no fatalities; however, 49 US soldiers were injured, two seriously. Most of the injuries were fractures, sprains, contusions, or lacerations suffered when troops scrambled over the 15-foot high perimeter wall to escape the North Compound (Figure 28).<sup>198</sup> In addition, four British troops received minor injuries.

<sup>195</sup> Letter from the Ministry of Defence (UK) to the Countess of Mar, February 2, 1998. p. 6.

<sup>196</sup> "History of Events," Army Accident Report 910711001, Fort Rucker, AL: US Army Safety Center, September 20, 1991, p. 1-3.

<sup>197</sup> Lead Sheet # 15493, Memorandum for Office of the Special Assistant for Gulf War Illnesses from former 11<sup>th</sup> ACR Engineer Officer, subject: "Summary of Personal Involvement and Observations Concerning Depleted Uranium at Camp Doha, Kuwait, 11 July -25 August 1991," March 16, 1998. p. 2.

<sup>198</sup> "Medical Aspects of Accident," Army Accident Report 910711001, Fort Rucker, AL: US Army Safety Center, September 20, 1991, p. 2.



Figure 28 - 11th ACR troops evacuate Doha's North Compound, July 11, 1991.

The post-blast destruction was overwhelming. One hundred and two vehicles were damaged or destroyed, including four M1A1 tanks and numerous other combat vehicles. More than two dozen buildings sustained damage as well.<sup>199</sup> Among the estimated \$14 million in munitions that had been damaged or destroyed were 660 M829 120mm DU sabot rounds.<sup>200</sup>

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<sup>199</sup>“History of Events,” Army Accident Report 910711001, Fort Rucker, AL: US Army Safety Center, September 20, 1991, p. 3-4.

<sup>200</sup>“Estimated Cost of Destroyed Ammunition,” Army Accident Report 910711001, Fort Rucker, AL: US Army Safety Center, September 20, 1991, p. 1.



Figure 29 - Aftermath of Doha motor pool fire (view of washrack area) showing armor hulks and UXOs.

- **Initial Recovery Efforts.**

Given Iraq's proximity, still-formidable striking power, and belligerence, rebuilding the 11<sup>th</sup> ACR's shattered combat potential was a matter of utmost urgency. The Regimental Commander and his staff had to restore basic life support functions (power, running water, sewage, cooking facilities, etc.) and a secure operating area, and then clear the motor pool areas so that serviceable vehicles could be recovered and the unit's combat readiness reconstituted. In planning recovery operations, the unit leadership viewed unexploded ordnance (UXOs) as by far the most significant, widespread, and deadly hazard. The blasts had deposited huge quantities of live ammunition of every description over the motor pool and in the adjacent life support area (figure 29).<sup>201,202</sup> This ordnance was highly unstable, a fact underlined the next day when a

<sup>201</sup>Lead Sheet # 15358, Interview of former 11<sup>th</sup> ACR Commander, March 6, 1998.

British EOD technician entering the North Compound stepped on a live artillery bomblet, seriously injuring his foot.<sup>203</sup>



Figure 30 - Burned DU rod and sabot

Although concern over UXOs predominated, the 11<sup>th</sup> ACR leadership was also concerned about possible radiological contamination from depleted uranium rounds that had "cooked off" and burned in the fire.<sup>204,205</sup> Three M1A1 (HA) tanks in the wash rack area (where the fire started) had been gutted by internal explosions of their mostly DU ammunition loads. Each M1A1 is assumed to have been uploaded with 37 M829 sabot rounds with DU penetrators and 3 non-DU HEAT rounds. In addition to the estimated 111 sabot rounds uploaded on the

burned tanks, several hundred other sabot rounds were stored in MILVANS trailers or conexes in the 2<sup>nd</sup> Squadron motor pool. Some of these had exploded in fires that were of such sustained intensity that steel howitzers and other equipment had melted, making it likely that many DU rounds had been damaged by oxidization in the fires.

It is clear from viewing contemporary logs and other data that the 22<sup>nd</sup> Support Command (SUPCOM), which supported combat units deployed into the theater, was aware of the potential for DU contamination. Entries from the SUPCOM LOC Sequence of Events (subject: Doha Fire) provide evidence of this awareness, as the following citations indicate:

(CG Card #3-Date-Time Group 11 1200C Jul)

ENTIRE 2 SQUADRON MOTOR POOL HAS BEEN AFFECTED BY THE FIRE. 35-40 VEHICLES ON FIRE, TO INCLUDE ENTIRE HOWITZER BATTERY. HOW BATTERY HAS 155MM AMMO UPLOADED. DEPLETED URANIUM ROUNDS ARE GOING OFF.

The significance of this message is amplified by a later entry (Card #10) at 2:30 PM (when the fire and explosions had largely subsided) that reads:

<sup>202</sup> Lead Sheet # 15493, Memorandum for Office of the Special Assistant for Gulf War Illnesses from former 11<sup>th</sup> ACR Engineer Officer, subject: "Summary of Personal Involvement and Observations Concerning Depleted Uranium at Camp Doha, Kuwait, 11 July -25 August 1991," March 16, 1998. p. 2.

<sup>203</sup> Lead Sheet # 6002, Interview of former 146<sup>th</sup> Ord. Det. (EOD) Commander, September 11, 1997, p. 1

<sup>204</sup> Lead Sheet #5720, Interview of former 11<sup>th</sup> ACR Engineer Officer, August 2, 1997.

<sup>205</sup> Lead Sheet # 15523, Interview of former 54<sup>th</sup> Chemical Troop Commander, March 19, 1998.

EOD POC (Explosive Ordnance Disposal Point of Contact) STATES THAT BURNING DEPLETED URANIUM PARTICLES WHEN BREATHED CAN BE HAZARDOUS. 11<sup>TH</sup> ACR HAS BEEN NOTIFIED TO TREAT THE AREA AS THOUGH IT WERE A CHEMICAL HAZARD AREA; i.e. STAY UPWIND AND WEAR PROTECTIVE MASK IN THE VICINITY.<sup>206</sup>

It is unclear whom, if anyone, passed this information to the 11<sup>th</sup> ACR. The former 11<sup>th</sup> ACR Commander was emphatic in stating that no such warning had ever reached him, and, if it had, he would have responded appropriately.<sup>207</sup> The Regimental Engineer, who directed recovery operations, reacted similarly when asked, on March 10, 1998, about the contents of the logs, and advised of a July 12, 1991 entry in the official diary of the 702<sup>nd</sup> Transportation Battalion (Provisional), which fell under the 22<sup>nd</sup> Support Command:

BN dispatches HET, LB, and FB trucks to KKMC to be in positions to support movement of replacement vehicles and ammunition to Doha. Troops are directed to carry protective masks due to possible Alpha particle contamination from depleted uranium rounds, which exploded in the accident area.<sup>208</sup>

The Regimental Engineer pointed out that the 11<sup>th</sup> ACR's own gas masks had been placed in storage upon their arrival on the base and were not issued or worn at any point during the clean-up—a directive, annotated in the unit's deployment orders, that he attributes to ARCENT. He added that he and other members of the unit leadership were directly involved in leading recovery operations in the North Compound.<sup>209</sup> It is illogical to suggest that they would have knowingly subjected themselves and their troops to a clearly identified hazard

Entry 32 of the SUPCOM log states:

1450 hrs (2:50 PM)—ARCENT G-3 called for Chemical Officer to do Downwind Predictions because of DU rounds. Message passed to (a Captain at the Forward Area Support Coordinating Office, or FASCO).<sup>210</sup>

The Chemical Officer referenced in the log is presumably the Nuclear-Biological-Chemical (NBC) Officer on the 11<sup>th</sup> ACR Commander's Staff. This officer would have been charged with advising the Commander of any NBC threats, as well as recommending appropriate action. As it happened, the former Regimental NBC officer had left on July 1, 1991, and his replacement did not arrive at Doha until the morning of the fire. Nonetheless, there were also two captains and three senior non-commissioned officers (sergeants) performing Staff NBC functions at the time of the fire. Contacted for this report, the senior NBC officer, a major, had

<sup>206</sup> "Doha Fire, SUPCOM LOC Sequence of Events Log," July 11, 1991.

<sup>207</sup> Lead Sheet # 15358, Interview of former 11<sup>th</sup> ACR Commander, March 6, 1998, p. 3.

<sup>208</sup> 12 July 1991 entry, 702D Transportation Battalion (Provisional) Battalion Operations Diary, Saudi Arabia (Part 1 of 2); Gulf War Collection, Group Swain Papers, SSG After-action Report, SSG 3<sup>rd</sup>-051, p. 4-13.

<sup>209</sup> Lead Sheet # 15454, Interview of former 11<sup>th</sup> ACR Engineer Officer, March 11, 1998, p. 1-2.

<sup>210</sup> "Doha Fire, SUPCOM LOC Sequence of Events Log," July 11, 1991.

no recollection of receiving specific guidance or direction from higher headquarters (ARCENT or the 22<sup>nd</sup> Support Command) regarding the potential hazard from DU. He emphasized that the unit-level NBC assets were trained, staffed, and equipped to deal with battlefield radiological hazards, rather than DU contamination, for which detection and remediation requirements are substantially different<sup>211</sup>

SUPCOM LOC Entry 42 (at 3:48 PM) states:

Regiment reports they have no capability to do "Airborne" monitoring. Will check to see if they have AN/PDR-27s. SUPCOM LOC initiating actions to locate "Airborne" capability.<sup>212</sup>

An airborne monitoring capability would have been invaluable in quantifying and documenting the presence or absence of alpha particles in areas downwind of the burned tanks and DU ammunition. However, the 11<sup>th</sup> ACR's organic NBC assets were not trained or equipped to monitor for airborne DU.

Although the Regimental leadership had a general awareness that DU could pose a radiological hazard, in the crucial days following the fire they lacked clear and authoritative guidance regarding the radiological characteristics of DU, its chemical toxicity, or methods by which these exposure hazards could be prevented or minimized.

SUPCOM was apparently aware of the regulatory requirement to establish a radiation control perimeter in response to the hazard of oxidized DU. SUPCOM LOC Entry 34 at 1456 hrs (2:56) states: "G-3 notified (a Lieutenant Colonel at FASCO) to start an "Alpha" Damage Assessment, and figure out total complacent area to be cordoned off."<sup>213</sup> Due to the UXO hazard, the North Compound was effectively sealed off for three days after the fire, with entry tightly controlled after that date.<sup>214,215,216</sup> The SUPCOM LOC log confirms this with Entry 69, entered in the log on July 11 at 10:00 PM. The entry reads:

(A Captain at FASCO) reported no movement because of FASCAM (artillery delivered mines) for 72 hrs in the area of vehicles per EOD guidance. This means no early recovery of damaged vehicles and no EOD activity for 72 hrs.<sup>217</sup>

Access to the 2<sup>nd</sup> Squadron motor pool and wash rack (the area holding the contaminated tanks) was even more restricted than for the North Compound in general.<sup>218</sup> No formal radiation

<sup>211</sup> Lead Sheet # 15517, Interview of former 11<sup>th</sup> ACR Regimental NBC Officer, March 18, 1998, p. 1-2.

<sup>212</sup> "Doha Fire, SUPCOM LOC Sequence of Events Log," July 11, 1991.

<sup>213</sup> "Doha Fire, SUPCOM LOC Sequence of Events Log," July 11, 1991.

<sup>214</sup> Lead Sheet # 6002, Former 146<sup>th</sup> Ord. Det (EOD) Commander, September 11, 1997, p. 1.

<sup>215</sup> Lead Sheet # 5728, Former 11<sup>th</sup> ACR Regimental Chemical Officer, July 10, 1997, p. 1-2.

<sup>216</sup> Lead Sheet # 5724, Former 54<sup>th</sup> Chemical Troop Commander, July 7, 1997, p. 1.

<sup>217</sup> "Doha Fire, SUPCOM LOC Sequence of Events Log," July 11, 1991.

<sup>218</sup> Lead Sheet # 15523, Interview of former 54<sup>th</sup> Chemical Troop Commander, March 19, 1998, p. 2.

control line was established, however, until after July 24, when a RADCON team from the US Army's Directorate of Safety Risk Management from the Communications and Electronics Command (CECOM) arrived at Doha.<sup>219</sup>

#### **Initial DU Contamination Assessment and Control Efforts.**

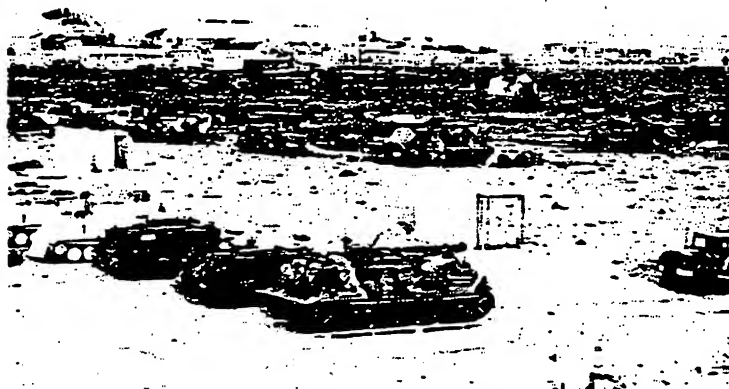


Figure 31 – Aftermath of Doha motor pool fire

Because an accident had occurred involving DU munitions and tanks with DU armor, a radiation control (RADCON) response was required in accordance with the Department of the Army Technical Bulletin (TB) 9-1300-278 and related directives. Two agencies, the US Army Armament Munitions and Chemical Command (AMCCOM), based at Rock Island, IL; and the US Army Communications Electronics Command based at Fort Monmouth, NJ, were notified and began preparing RADCON response teams for

deployment to Doha. In the first week after the mishap, however, the 11<sup>th</sup> ACR had to rely primarily on its own resources to initiate clean up and recovery operations.

On July 12, the day after the blast, the 11<sup>th</sup> ACR leadership completed a preliminary damage assessment and began formulating plans and establishing priorities for the massive clean-up and recovery operation. The Regiment Commander had three primary assets at his disposal for handling the specialized tasks the cleanup would require. These were:

- The 146<sup>th</sup> Ordnance Detachment (EOD)
- The 54<sup>th</sup> Chemical Troop.
- The 58<sup>th</sup> Combat Engineer Company.

Since these units provided the first response to the accident, and would continue to play a key role for the duration of the clean up, a discussion of their roles and activities is in order.

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<sup>219</sup>Lead Sheet # 5997, Interview of CECOM Team Head, July 16, 1997, p. 2.

- **Role and Activities of the 146<sup>th</sup> Ordnance Detachment (EOD)**

The 146<sup>th</sup> Ordnance Detachment (EOD) had two EOD technicians at Doha on the morning of the blast, and deployed most of its remaining members (approximately 10-12 personnel) from King Khalid Military City (KKMC) and Dhahran, in Saudi Arabia, to Doha over the next two or three days. Their focus was on disarming and removing the huge quantities of unexploded ordnance (UXOs) scattered all over the base by the force of the explosions.



Figure 32 - EOD personnel at Doha

After the initial blast, the North Compound was sealed off for three days because of the threat from delayed-action FASCAM mines that might have armed during the explosions and fire. For two days the EOD team developed a plan of action in coordination with the engineers.<sup>220</sup>



Figure 33 - DU rods collected at Doha

EOD troops were aware of the presence of DU and were familiar with the potential hazard that it posed. More importantly, they were trained and equipped to detect DU contamination. Their initial survey, which was limited due to the quantity of UXOs in the North Compound, found very little DU outside the immediate vicinity of the three destroyed tanks.<sup>221</sup> The standard uniform for UXO clearing was a flak jacket and kevlar helmet, with gloves worn when debris was moved. Because of the extreme heat, only T-shirts were worn under the flak vests. EOD and combat engineer troops (and later, line

troops) were not provided with, and did not wear, protective suits, respirators, or dust masks to wear during clearing and cleaning operations.<sup>222</sup>

<sup>220</sup> Lead Sheet # 6002, former 146<sup>th</sup> Ord. Det. (EOD) Commanding Officer, Oct 6, 1997

<sup>221</sup> Lead Sheet # 5732, former 146<sup>th</sup> Ord Det (EOD) SFC, September 25, 1997, p. 1-2.

<sup>222</sup> Lead Sheet # 15493, Memorandum for Office of the Special Assistant for Gulf War Illnesses from former 11<sup>th</sup> ACR Engineer Officer, subject: "Summary of Personal Involvement and Observations Concerning Depleted Uranium at Camp Doha, Kuwait, 11 July -25 August 1991," March 16, 1998, p. 2-3.



Most of the DU rounds at Doha had been uploaded on the tanks, all but three of which had survived the fire intact. A fourth tank suffered minor external damage, but its load of ammunition and fuel had not combusted. Other DU rounds were stored in conex containers in the immediate vicinity of the tanks. The conexes held each platoons' field-deployable ammunition stocks: allocations of 7.62mm, .50 cal., and heavier munitions, including DU.

Post-blast photos show many intact conexes among the burned-out wreckage (figure 34). The commander of the 146th Ordnance Detachment (EOD) stated that stored ammunition is more stable than is generally believed, and is fairly survivable except when directly exposed to fires, extreme heat, or explosions. Even in the conexes that blew up, typically only a few shells would detonate, scattering the other rounds rather than touching off a massive "sympathetic" detonation. This explains the huge quantity of unexploded ordnance (UXOs) littering the motor pool area.<sup>223</sup> Large numbers of the lightweight

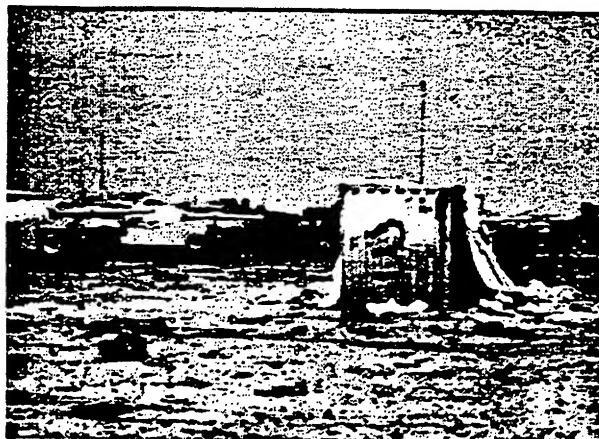


Figure 34 - Surviving Munitions Conex

FASCAM submunitions had been flung into the South Compound, but the heavier rounds, such as TOW anti-tank missiles (and all of the DU penetrators, evidently) remained in the North Compound.



Figure 35 - Marked DU rod and sabot

The cleanup plan for the North Compound involved EOD personnel working together with the 58th Combat Engineering Company to find, mark, render safe, and remove UXOs. The former 146<sup>th</sup> Ord. Det. (EOD) Commander states that "Engineers didn't pick up any DU unless an EOD guy told them to." EOD marked the DU rounds they found with orange spray paint, painting a circle around the penetrator, and wore leather gloves to pick them up. Exposed DU penetrators were wrapped in heavy plastic and put in wooden boxes or 55-gallon drums. Later, after the AMCCOM Radiation Control team had arrived at Doha, the DU was placed inside one of the destroyed tanks for

retrograding and disposal at the Defense Consolidation Facility (DCF), Snelling, SC.<sup>224,225</sup>

<sup>223</sup>Lead Sheet # 6002, former 146<sup>th</sup> Ord. Det. (EOD) Commanding Officer, Oct 6, 1997, p. 1.

<sup>224</sup>Lead Sheet # 6002, Interview of former 146<sup>th</sup> Ord. Det. (EOD) Commander, October 6, 1997, p. 2.

<sup>225</sup>Lead Sheet # 6481, Interview of former 146<sup>th</sup> Ord. Det. (EOD) Sergeant First Class, October 20, 1997, p. 2.

Despite the 146<sup>th</sup> Ord. Det. Commander's statement, it appears that some Engineer troops, including their commander, picked up DU (generally with leather gloves, but in some cases with bare hands) to allow EOD to concentrate on UXOs.<sup>226</sup>

Most if not all of the DU penetrators recovered in the North Compound were picked up within a 120-meter radius of the three destroyed M1A1s. EOD members contacted for this report believed those rounds came from the nearby conexes, rather than the tanks, since the design of the M1A1s' blast panels did not allow most of the intact DU rounds to escape.<sup>227</sup>

EOD members viewed the staggering quantities of UXOs they had to contend with as the most grave and immediate threat at Doha. By its nature, explosive ordnance disposal is an extremely dangerous undertaking, and the sheer magnitude of the task facing the 146<sup>th</sup> Ord Det. at Doha cannot be overstated. These hazards were tragically underscored on July 23, twelve days after the initial blast and fires. Two senior EOD non-commissioned officers and a 58<sup>th</sup> CEC soldier died instantly in an accidental UXO blast. The fatal mishap had a significant impact on the remainder of the clean-up effort, and, particularly, on the 146th Ordnance Detachment.



Figure 36 - UXOs in Doha's North Compound

Between the July 11 fire and the July 23 EOD mishap, the 146th Ordnance Detachment had cleared most of the South Compound and periphery of the North Compound, and about 1/3 of the 2<sup>nd</sup> Squadron motor pool. After July 23, all personnel were prohibited from entering the North Compound, except for a small area at some distance from the 2<sup>nd</sup> Squadron motor pool where supply operations and other activities were being conducted. This area had survived the blast/fires more or less unscathed, except for UXOs that were soon cleared.<sup>228</sup> Interviews with EOD, Engineer, and other 11th ACR personnel have indicated that no spent (exposed) DU penetrators, fragments, or residues were found in this location.

<sup>226</sup>Lead Sheet # 15493, Memorandum for Office of the Special Assistant for Gulf War Illnesses from former 11<sup>th</sup> ACR Engineer Officer, subject: "Summary of Personal Involvement and Observations Concerning Depleted Uranium at Camp Doha, Kuwait, 11 July -25 August 1991," March 16, 1998, p. 2.

<sup>227</sup>Lead Sheet # 6002, former 146<sup>th</sup> Ord. Det. (EOD) Commander, October 6, 1997.

<sup>228</sup>Lead Sheet # 6653, former US Army COR to ECC, October 31, 1997, p. 2.

## - Role and Activities of the 54<sup>th</sup> Chemical Troop

In the immediate aftermath of the July 11 fires and explosions, the task of monitoring for radiological contamination fell on the 54<sup>th</sup> Chemical Troop, the 11<sup>th</sup> ACR's primary asset for responding to nuclear, biological, or chemical (NBC) hazards. On the morning after the blast, the 54<sup>th</sup> Chemical Troop conducted initial monitoring for alpha, beta, and gamma radiation of the periphery of the North Compound using Fox chemical and radiological detection vehicles and hand-held radiation detectors.<sup>229,230</sup>

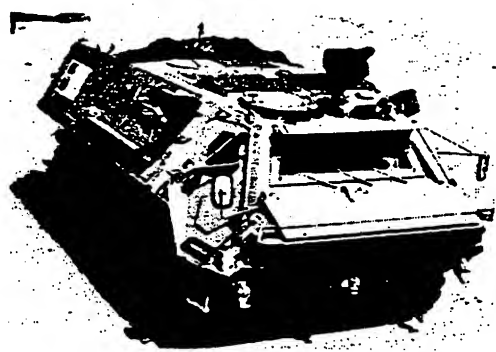


Figure 37 - M93 Fox NBC vehicle

The M-93 Fox vehicle deployed with the 54<sup>th</sup> Chemical Troop is a sophisticated chemical weapons detector. Built in Germany and widely regarded as the best chemical detection vehicle in service, it has a secondary capability to detect beta and gamma radiation, with a very limited alpha detection capability. The Foxes had two on-board radiation detectors: the German-made ASG-1 and the US AN/VDR-2. The Reconnaissance Platoon of the 54<sup>th</sup> Chemical Troop operated and maintained six of the vehicles, with a seventh Fox serving as a "floater" or spare. Each Fox had four crewmen.<sup>231</sup>

The initial radiological monitoring effort was conducted on July 12, the day after the fire, by three Fox vehicles. The 54<sup>th</sup> Troop Commander and other troop personnel have indicated in recent interviews that their monitoring equipment was fully operational and calibrated. The Foxes conducted radiation surveys around the North Compound's perimeter and inside the South Compound.<sup>232,233</sup> The 54<sup>th</sup> Chemical Troop Commander acknowledged, in a March 1998 meeting with investigators, that while he and his Troop were well-trained to detect battlefield radiation, they had little training or experience with DU and its alpha radiation. However, he had been directed by his superiors to use the Fox vehicles in this role, and so he did.<sup>234</sup> Troop personnel also entered the motor pool area on foot a week after the blast (July 18), using hand-held VDR-2 monitors to check for beta and gamma radiation. These forays produced "negative" readings for radiation.<sup>235</sup>

<sup>229</sup>Lead Sheet #5724, Interview of former 54<sup>th</sup> Chemical Troop Commander, July 7, 1997, p. 1-2.

<sup>230</sup>Lead Sheet # 5731, Interview of former 54<sup>th</sup> Chemical Troop Reconnaissance Platoon NCO, July 15, 1997, p. 1.

<sup>231</sup>Lead Sheet #5730, Interview of former 1<sup>st</sup> Reconnaissance Platoon Leader, 54<sup>th</sup> Chemical Troop, July 14, 1997, p. 2.

<sup>232</sup>Lead Sheet #5724, Interview of former 54<sup>th</sup> Chemical Troop Commander, July 7, 1997, p. 1-2.

<sup>233</sup>Lead Sheet # 15492, Interview of former 54<sup>th</sup> Chemical Troop Reconnaissance Platoon Leader, March 25, 1998, p. 1.

<sup>234</sup>Lead Sheet # 15523, Interview of former 54<sup>th</sup> Chemical Troop CO, March 19, 1998.

<sup>235</sup>Lead Sheet # 5731, Interview of former 54<sup>th</sup> Chemical Troop Reconnaissance Platoon NCO, July 15, 1997, p. 2.

The former Regimental NBC officer and several former 54<sup>th</sup> Chemical Troop members, including the Platoon Leader of the 54<sup>th</sup> Reconnaissance Platoon which operated the Fox vehicles, have indicated some doubts about these initial surveys since they lacked the proper equipment to detect the most widespread contaminant: alpha radiation. Alpha radiation could only be detected at extremely close ranges (an inch or less), with a specialized alpha-detection probe held directly above the suspected contamination. On the other hand, DU also emits beta and gamma radiation in sufficient quantity to detect the presence of visible pieces of DU using common beta/gamma survey instruments. In addition, the Foxes were carrying out operations in the South Compound and around the periphery of the motor pool, where the likelihood of detectable levels of DU contamination was very low. These concerns were voiced to the Regimental Commander.<sup>236</sup> Based on this preliminary assessment and a similar input from the first RADCON responder on the scene, the Regimental Commander directed the Foxes to discontinue their monitoring efforts shortly afterwards.<sup>237</sup>

The 54<sup>th</sup> Chemical Troop (and the NBC Regimental Staff members at Doha) conducted limited operations inside the North Compound due to the huge quantities of UXO, and collateral efforts by EOD and RADCON personnel. While they did not play a major role in detecting or cleaning up DU alpha particle contamination at Doha, they helped pick up visible DU penetrator rods and fragments.<sup>238</sup>

- **Role and Activities of the 58<sup>th</sup> Combat Engineer Company (CEC)**



Figure 38 - North Compound

The 58<sup>th</sup> Combat Engineer Company, the 11<sup>th</sup> ACR's organic Engineer element, had the primary responsibility for the clean-up and recovery effort. Working closely with the 146th Ord. Det. (EOD), and later with a contract EOD team, the 58<sup>th</sup> CEC used its bulldozers and graders to clear heavy debris from the North Compound after EOD personnel had cleared away UXOs and exposed DU penetrators. As such, the 58<sup>th</sup> CEC represented the largest contingent of personnel who operated in the North Compound during cleanup and recovery operations. Former 146th Ord. Det. (EOD) personnel have stated that 58<sup>th</sup> CEC troops

were given safety briefings prior to entering the North Compound warning them to alert EOD technicians when they found UXOs and DU. For obvious reasons, Engineer Troops avoided

<sup>236</sup>Lead Sheet #5728, Interview of former 11<sup>th</sup> ACR Chemical Officer, July 10, 1997, p. 1; Lead Sheet #5730, Interview of former 54<sup>th</sup> Chemical Troop Reconnaissance Platoon Leader, July 14, 1997; and Lead Sheet #5731, Interview of former 54<sup>th</sup> Chemical Troop Reconnaissance Platoon Sergeant, July 15, 1997.

<sup>237</sup>Lead Sheet #5724, Interview of former 54<sup>th</sup> Chemical Troop CO, July 7, 1997, p. 2.

<sup>238</sup>Lead Sheet # 15523, Interview of former 54<sup>th</sup> Chemical Troop CO, March 19, 1998, p. 2.

UXOs; however, some have stated that they did not recall being briefed on DU, and therefore picked up exposed DU penetrators, which they did not realize were hazardous material.

- **Impact of the fatal July 23 UXO mishap**

Following the July 23 UXO blast, ARCENT (the 11<sup>th</sup> ACR's in-theater higher headquarters) immediately halted cleanup activities in the North Compound while they reassessed the situation at Doha. From that point on, the 146<sup>th</sup> Ord. Det. (EOD) was effectively sidelined, relegated to providing support to the AMCCOM and CECOM personnel who had arrived on July 19 and July 24, respectively, to decontaminate and retrograde (remove) the contaminated M1A1 tanks.<sup>239,240</sup>

Due to the magnitude of the UXO contamination, ARCENT brought in the 512<sup>th</sup> EOD Control Team and a civilian EOD contract company staffed by ex-military EOD technicians to finish the clean-up of Doha's North Compound (the South Compound had already been cleared by the 146<sup>th</sup> Ord. Det.). This resulted in a near suspension of activity in the North Compound from July 23 until mid-September.<sup>241,242</sup>

- **Arrival and Activities of Radiation Control Teams**

While the 146<sup>th</sup> Ord. Det. (EOD), 54<sup>th</sup> Chemical Troop, and 58<sup>th</sup> Combat Engineer Company played key roles in the clean-up and recovery operation, the stringent demands of handling and disposing of DU contaminated equipment required the commitment of additional resources. It should be noted that regulatory radiation control measures mandated by Army and NRC regulations had been written for peacetime accidents at stateside military installations. Nonetheless, a RADCON response was required. It came initially from two Radiation Control teams deployed from appropriate agencies in the United States, and later from the Environmental Chemical Corporation, which, as mentioned, conducted the final clean-up of UXO and DU contamination at Doha.

The Industrial Operations Command (formerly Armament Munitions and Chemical Command, or AMCCOM) based at Rock Island, Illinois, maintains the Nuclear Regulatory Commission (NRC) license authorizing storage of Army DU ammunition at Army installations within the United States and US territories.<sup>243</sup> Since the Doha explosion involved DU, the Army directed AMCCOM to assemble and deploy a team to assess the levels of DU contamination in and around the damaged/destroyed tanks.<sup>244</sup>

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<sup>239</sup> Lead Sheet # 6002, Interview of former 146<sup>th</sup> Ord. Det. (EOD) Commander, October 6, 1997.

<sup>240</sup> Lead Sheet # 6481, Interview of former 146<sup>th</sup> Ord. Det. (EOD) Sergeant First Class, October 20, 1997.

<sup>241</sup> Lead Sheet # 6002, Interview of former 146<sup>th</sup> Ord. Det. (EOD) Commander, October 6, 1997.

<sup>242</sup> Lead Sheet # 6481, Interview of former 146<sup>th</sup> Ord. Det. (EOD) Sergeant First Class, October 20, 1997.

<sup>243</sup> Guidelines For Safe Response to Handling, Storage, and Transportation Accidents Involving Army Tank Munitions or Armor Which Contain Depleted Uranium, Department of the Army TB 9-1300-278 Washington, DC: Headquarters, Department of the Army, July 21, 1996, p. 1-2.

<sup>244</sup> Lead Sheets #5698 and #5699, Interviews of AMCCOM members

Several hundred 120mm DU sabot rounds stored in the motor pool area had exploded, leaving behind the DU penetrator rod. Intact, these penetrators, 27 inches long and 1.5 inches thick, weighed 10.7 pounds.<sup>245</sup> The first AMCCOM representative to enter the North Compound on July 18 stated that the motor pool in total contained about 900 DU rounds, of which all but 10-40 had been uploaded in the tanks. He was able to find five spent DU rounds (intact) within 150 meters of the tanks. Although his preliminary assessment was limited, due to the extraordinary quantity of UXOs, his initial reaction was that the area was not nearly as badly contaminated as first believed.<sup>246</sup> He was apparently unaware that several hundred DU sabot rounds were stored in MILVANS and conexes.

The 3-man AMCCOM Radiation Control team arrived at Camp Doha on July 19th. The team's mission was limited to assessing the state of the M1A1 tanks, and then decontaminating the damaged or destroyed tanks to allow their entry into the United States for decontamination or preparation for disposal at a low-level radioactive waste disposal site at Barnwell, SC. Although the team was equipped with a variety of sophisticated radiological detection equipment, it essentially limited its activities to collecting DU penetrators found in and around the tanks, and preparing the tanks for shipment to the port of Dammam, where they would be readied for shipment to the US.<sup>247</sup>

Upon its arrival at Doha, the AMCCOM team did a visual inspection of the motor pool, accompanied by members of the 54<sup>th</sup> Chemical Troop and some EOD personnel. The North Compound had been cordoned off since the blast, with entry strictly controlled and limited almost exclusively to 58<sup>th</sup> Combat Engineers and 146<sup>th</sup> Ord. Det. (EOD) personnel involved in UXO clearing operations.<sup>248</sup> Later, after lanes had been cleared through areas of UXO concentrations, small groups of drivers were brought in to move operational equipment out of the motor pool area to a new site some distance away.<sup>249</sup>

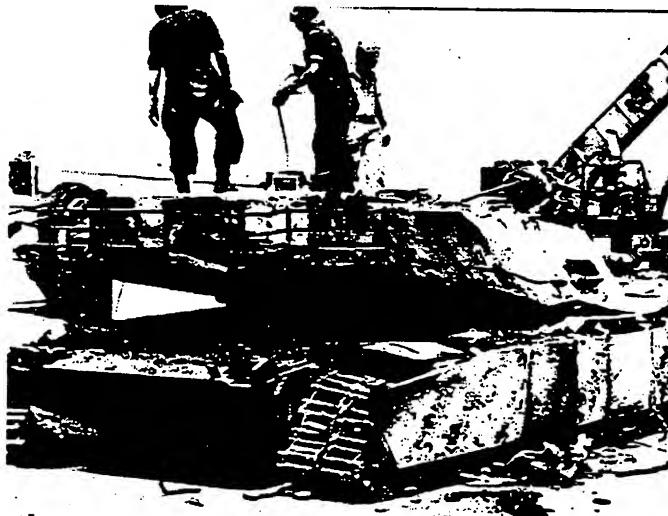


Figure 39 - AMCCOM RADCON Personnel at Doha

<sup>245</sup> Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report, Atlanta, GA: US Army Environmental Policy Institute, Georgia Institute of Technology, June 1995, p. 39.

<sup>246</sup> Memorandum for Record, telephone report from SWA Radiation Protection Office, on update of status of Doha accident site, July 18, 1991.

<sup>247</sup> Lead Sheet #5698, Interview of former AMCCOM team member August 8, 1997 and Lead Sheet #5699, Interview of AMCCOM Team head, July 25, 1997.

<sup>248</sup> Lead Sheet #5699, Interview of AMCCOM Team head, July 25, 1997.

<sup>249</sup> Lead Sheet #6002, Interview of former 146th Ord. Det. (EOD) Commander, October 6, 1997.

The AMCCOM team found that almost all of the DU rounds in each tank's basic load had remained inside the hull. Most of the penetrators found in the tanks were scorched but intact. Others had melted, fragmented, or oxidized to some degree in the intense heat.<sup>250</sup> These observations were corroborated by the Battle Damage Assessment Team from the US Army Ballistic Research Laboratory, which examined the four destroyed or damaged M1A1s. In a memorandum dated August 5, 1991, the Team stated:

All four of the M1A1s were damaged/destroyed as a result of fires external to the vehicle. *There were no penetrations anywhere of the exterior armor* (emphasis added). Three of the four M1A1s had their fuel and ammunition destroyed. In these three cases, there was an explosion in the ammunition compartment. The ammunition doors and blowout panels functioned properly, keeping the blast from entering the crew compartment. The fourth M1A1 was damaged on the right suspension only, and except for the gunner's computer and transmission warning lights, was completely operational.<sup>251</sup>

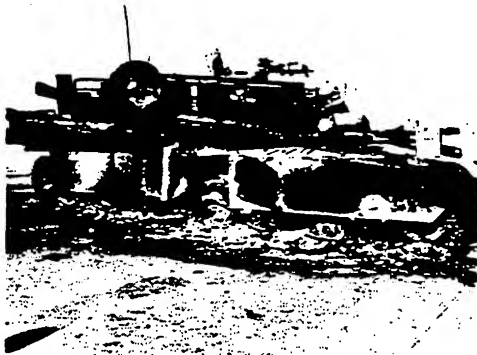


Figure 40 - Burned-out Doha M1A1

The above memo indicates that concerns about the M1A1's DU Heavy Armor panels burning and adding to the DU contamination appear to be misplaced. In order for oxidization to occur, the DU armor panels, sealed between (and shielded by) regular rolled homogenous steel armor, would have required exposure to air as well as to intense, sustained heat. Since the tanks' structural integrity remained intact, the possibility of contamination from burning DU armor is negligible.

A small number of DU rounds were ejected from the burned tanks through their blast panels, designed to allow the escape of the extreme overpressures created during an ammo-compartment explosion. The anecdotal evidence collected, however, suggests that very few rounds were ejected in this manner.<sup>252,253</sup>

After the head of the team ascertained that the 54<sup>th</sup> Chemical Troop members were familiar with the operation of the hand-held PDR-77s (alpha detectors) the team employed, he led them on a limited survey of the motor pool and its periphery. Again, the danger from UXOs prevented a more comprehensive effort. The AMCCOM members also inspected the burned-out tanks.

<sup>250</sup> Lead Sheets #5699, Interview of AMCCOM Team head, July 25, 1997; and Lead Sheet #5997, Interview of CECOM Team head, July 16, 1997.

<sup>251</sup> Memorandum for Commander, 22 Support Command, APO NY, Subject: "Damage Assessment at Camp Doha," August 5, 1991.

<sup>252</sup> Lead Sheet #6002, Interview of former 146<sup>th</sup> Ord. Det. (EOD) Commander, October 6, 1997.

<sup>253</sup> Lead Sheet # 6481, former 146<sup>th</sup> Ord. Det. (EOD) Sergeant First Class, October 20, 1997.



After a team member nearly stepped on a live artillery bomblet, EOD and Engineer troops cleared a lane to facilitate access to the tanks.<sup>254</sup>

Although the AMCCOM mission was limited in scope, they seem to have elevated the issue of DU to new prominence. Prior to the AMCCOM team's arrival, DU penetrators picked up by Engineer or EOD personnel were deposited in an on-base trash pile. The AMCCOM team halted this practice, segregating and retrieving the DU penetrators for proper disposal. Enough DU penetrators were collected to fill at least two 55-gallon drums. These penetrators were dumped inside one of the burned-out M1A1 tanks identified for shipment to the Defense Consolidation Facility at Snelling, SC.<sup>255</sup>

Communication between the AMCCOM (and later, CECOM) RADCON responders and the leadership of the 11<sup>th</sup> ACR appears to have been spotty at best. The Regimental Engineer Officer recalls that he knew nothing about the arrival of the AMCCOM personnel until they showed up at Doha. He also stated that the 11<sup>th</sup> ACR Commander had a direct question put to the first RADCON responder: "Is there a radiological hazard (at Doha)?" The response was negative.<sup>256</sup> This response, however, apparently did not address the issue of DU's chemical toxicity. RADCON members apparently had little interface, formal or informal, with the 11<sup>th</sup> ACR Commander or his staff.<sup>257,258,259</sup>

- **CECOM Team Augments Radiation Control Efforts**

On July 24<sup>th</sup>, the day after the fatal EOD blast, a team arrived at Doha from the Communications and Electronics Command (CECOM) based at Ft. Monmouth, NJ. The CECOM team was headed by the Project Director for the US Army Radiological Control Team, Headquarters, Department of Army Operations. Using Eberline Field Instruments for the Detection of Low Energy Radiation (FIDLER) and SPA-3 gamma detectors, the team conducted what one member called a "site characterization survey."<sup>260</sup> These surveys located a sizable number of DU fragments and areas of DU contamination, but were hampered by the general "background" gamma radiation fields from the DU in the tanks and ammunition. This was not a grid-by-grid survey, but rather a more general sampling, mostly in and around the motor pool. The CECOM team surveyed all areas cleared by EOD (an estimated two or three acres of the motor pool, which was the size of several football fields).

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<sup>254</sup> Lead Sheets #5724, 5728, 5730, 5732.

<sup>255</sup> Lead Sheet #5699, Interview of AMCCOM Team head, July 25, 1997, p. 3; and Lead Sheet #5720, 11<sup>th</sup> ACR Engineer Officer, July 16, 1997.

<sup>256</sup> Lead Sheet #5720, Interview of former 11<sup>th</sup> ACR Regimental Engineer, July 7, 1997, p. 2.

<sup>257</sup> Lead Sheet # 15854, Interview of ARCENT Radiation Protection Officer, April 6, 1998, p. 2.

<sup>258</sup> Lead Sheet 15358, Interview of former 11<sup>th</sup> ACR Commander, March 6, 1998, p. 3.

<sup>259</sup> Lead Sheet # 15493, Memorandum for Office of the Special Assistant for Gulf War Illnesses from former 11<sup>th</sup> ACR Engineer Officer, subject: "Summary of Personal Involvement and Observations Concerning Depleted Uranium at Camp Doha, Kuwait, 11 July -25 August 1991," March 16, 1998, p. 3-4.

<sup>260</sup> Lead Sheet #5993, Interview of former CECOM Team Member, August 7, 1997.



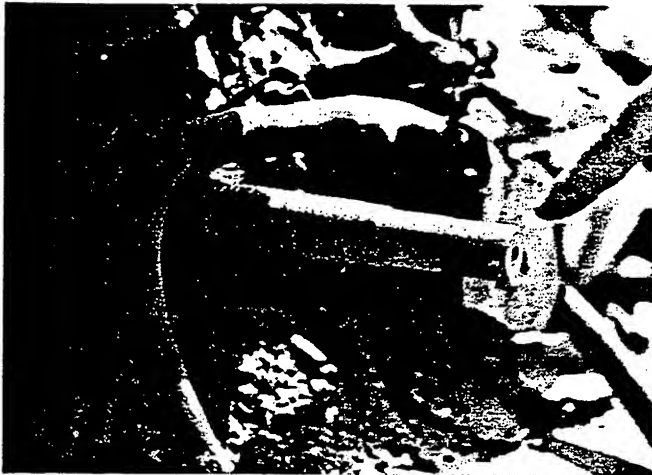


Figure 41 - DU rod found in Doha dump

Three 55-gallon drums containing DU penetrators and a separate pile of burned penetrators were placed into the three contaminated tanks for shipment to the US. Seven M8A1 Chemical Agent Alarm Systems containing Americium-241 were also involved in the fire. One was recovered from the area cleared by EOD. The radioactive source cell was not damaged. One additional M8A1 was recovered from one of the M1A1 tanks removed from the area near the wash rack. The radioactive source cell was penetrated by a fragment from the explosion and burned in the fire. No alpha radiation

contamination was detected. This M8A1 was placed in one of the contaminated M1A1 tanks for shipment to the US for disposal. The dumpsite located near the camp (where post-accident debris was discarded) was also surveyed. The survey found one DU penetrator (see Figure 41) which was recovered for disposal.

A July 31, 1991 CECOM report submitted to the to the Commander, Task Force Victory, Forward (which was overseeing the overall Doha recovery effort) reported no radiation hazard to personnel existed outside the exclusion area (the North Compound). It advised that five M8A1s and an unknown number of DU penetrators in solid, melted, and burned states remained in the exclusion area, and recommended that all persons entering that area be made aware of the potential hazard. After arrangements were made for the contaminated tanks to be shipped to the port of Dammam for shipment back to the US on August 6, 1991, the CECOM team departed Doha in early August.<sup>261,262</sup>

As sections of the 2<sup>nd</sup> Squadron's concrete pad were cleared of UXOs and DU, regular support and combat troops were brought in to do a final clean-up using brooms and other hand tools.<sup>263</sup> While the area with the heaviest concentration of depleted uranium contamination—the three burned M1A1s on the washrack—was cleaned up by RADCON personnel, the surrounding areas could have held residual DU oxides or residues. In addition, several hundred spent DU penetrators had been scattered and in some cases partially burned and oxidized in and around the MILVANS containers holding each platoon's ammunition resupply load.<sup>264</sup> These particles, if

<sup>261</sup> Memorandum for Commander, Task Force Victory (Fwd), Subject: "Camp Doha Accident Survey Update," August 2, 1991, p. 1.

<sup>262</sup> Lead Sheet #5993, Interview of former CECOM Team Member, August 7, 1997; and Lead Sheet #5997, Interview of former CECOM Team Chief, July 16, 1997.

<sup>263</sup> Lead Sheet # 15493, Memorandum for Office of the Special Assistant for Gulf War Illnesses from former 11<sup>th</sup> ACR Engineer Officer, subject: "Summary of Personal Involvement and Observations Concerning Depleted Uranium at Camp Doha, Kuwait, 11 July -25 August 1991," March 16, 1998, p. 3.

<sup>264</sup> Lead Sheet # 6653, Interview of former US Army Contracting Officer's Representative to ECC, October 31, 1997. p. 2.

resuspended (stirred up) by brooms, could have been inhaled or otherwise internalized by soldiers in the vicinity.

- **Post-M1A1 Retrograde Radiation Control and Clean-up Activity**

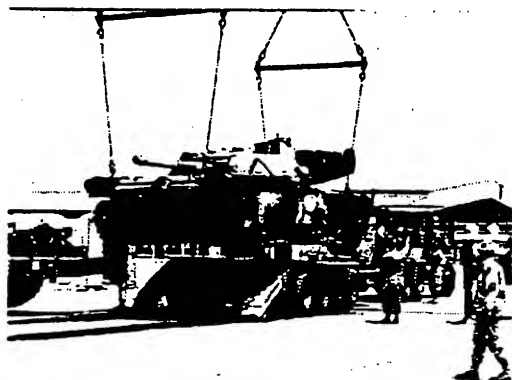


Figure 42 - Removing burned M1A1

Following the removal of the contaminated M1A1 tanks and the departure of the AMCCOM and CECOM teams on August 2, a hiatus in Radiation Control and clean-up activities ensued for several weeks. The only activity that took place in the North Compound during this time frame was in the supply area several hundred meters away from the 2<sup>nd</sup> Squadron motor pool area, which had been cleared earlier of UXOs thrown into the area by the July 11 explosions. No ammunition was stored in this location, and no DU was found in or near this area.

The 146th Ord. Det. (EOD) was rotated out of the theater in September 1991, after having been virtually sidelined since July 23. A civilian firm, Environmental Chemical Corporation (ECC), was contracted to finish all clean up and recovery activity in the North Compound. Two reserve Army EOD officers managed the contract and overall effort, while a highly trained and experienced Army Sergeant First Class (SFC) provided on-scene oversight, support, and safety monitoring to approximately 14 ECC EOD technicians. In this capacity, the SFC conducted most of the actual radiological survey efforts that were carried out in the second, final phase of the Doha clean up.

The ECC team brought their own radiation detection and measurement equipment and performed survey activities in the North Compound. Upon entering the 2nd Squadron motor pool, they found large quantities of DU scattered around the vicinity of the MILVAN containers (used for ammo storage) that had detonated in the fire. Many of these DU penetrators were intact, but others had fragmented or burned down to varying degrees, with some almost completely reduced. Some had been ejected into the open by the "kick-out" effect of individual rounds exploding among the stacked ammunition. Others, burned or unexploded, remained within the shells of the conexes. Using an AN/PDR-56 fitted with the small alpha probe, the SFC measured the DU cores and, after they were picked up, monitored the surface underneath them. Most of

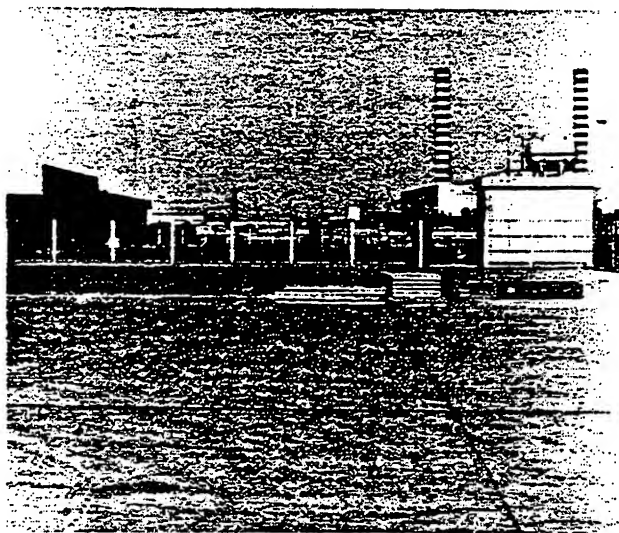


Figure 43 - Doha motor pool pad after clean-up

the DU cores and, after they were picked up, monitored the surface underneath them. Most of

the DU penetrators inside and outside the conexes gave off very low radiation readings. The DU penetrators were then double-wrapped in plastic, bubble-wrapped, and placed in 55-gallon drums. Personnel packing the drums with DU penetrators wore surgeon's caps, safety glasses, half face protective masks, coveralls, butyl rubber aprons, rubber surgeon's gloves with cotton inserts, and rubber "booties" over their normal work boots. A total of eight drums were filled with about 250 DU penetrators.

The SFC took readings inside the MILVAN containers, where levels of radiation were somewhat higher. He typically measured 4,500 counts per minute on the surface of the penetrator rods, reported as 9,000 disintegrations per minute (dpm, or the number of radioactive particles that decay per minute) multiplied by a correction factor of two. The levels on the surface of the ground directly beneath the penetrator were typically half the levels on the surface of the penetrator rod, or 2,200-2,300 cpm (corrected to 4,500-4,600 dpm). At the 10,000-dpm level, the military requires personnel to wear an M17A1 protective mask (gas mask) or equivalent respiratory protection. Given the reading of approximately 9,000 dpm, ECC elected to don white surgeon's masks in addition to their other protective gear while working on the motor pool pad. ECC personnel brushed down the containers until the radiation levels had reached natural background levels.

The SFC took readings on the surfaces the four burned-out (and DU-contaminated) M1A1 tanks had occupied. Since those areas had already been cleaned, they produced no readings for radiation.

- **The Final Clean-up**

When the ECC team started work in mid-September 1991, approximately two-thirds of the North compound remained uncleared, and due to the UXO threat, no one was permitted into those areas. It took the ECC team two months to get these areas cleaned up. Once explosive munitions were deemed safe for transport, they were moved to the EOD demo area approximately 750 meters east of the compound to be destroyed. All submunitions that were considered unsafe to transport were destroyed in place. Once the concrete pads had been cleared of ordnance and possible alpha contamination, heavy equipment was used to scrape up remaining debris and transport it to the EOD demolition area. As a precaution, diesel fuel was poured over the scrap metal and ignited to detonate or destroy any small-arms rounds or submunitions that might have been missed. This was done twice.

When the entire North Compound and the sandy strip between the North and South Compounds had been cleared, third-country nationals were hired to perform the final sweeping of the motor pool pads. These individuals were provided with dust masks, gloves, cotton overalls, and other personnel protective equipment, although the levels of radiation detected fell below the Army's criteria for donning M17 or similar gas-mask type respirators. When the motor pool had been swept completely clean, eleven water tankers were brought in to do a final, thorough "hose-down." When this process was complete, the Army EOD Control Team performed a radiological survey to ensure that no residual contamination remained. When none was found,

the contractor was certified as having fulfilled all contractual obligations to clean up the North Compound and its periphery.<sup>265</sup>

- **Working Conditions During the Doha Clean up and Recovery Operations.**

No discussion of the Doha cleanup would be complete without describing the extremely severe environmental and working conditions. Summer temperatures typically reached 115 degrees by mid-afternoon. Smoke from oil fires billowed constantly, coating the western surfaces of poles, walls, and parked vehicles with a black film and forcing soldiers to don handkerchiefs over their mouths and noses. Life support facilities, marginal before the fire, were practically wiped out. Since a serious water shortage was in effect, soldiers often wore the same uniforms for days on end. Biting sand flies and other parasites and pests were common. During the initial phase of the clean up, soldiers typically labored in these conditions twelve or more hours a day, often seven days a week.<sup>266</sup>

Department of the Army Technical Bulletin (TB) 9-1300-278, "Guidelines For Safe Response To Handling, Storage, And Transportation Accidents Involving Army Tank Munitions Or Armor Which Contain Depleted Uranium" (dated September 1990) states:

Anyone passing over (the radiation control line) to the fire area is to wear appropriate protective equipment that may include protective coveralls, gloves, rubberized boots, head covering, and respiratory protection. EOD personnel are to wear the M25 or M17A2 protective mask with the M13A2 filter element and the accompanying head covers (i.e., MOPP Level 4). Personnel assisting in the radiation survey and decontamination operations should wear full-face respirators with high-efficiency dust filters. Tape is to be used to seal the clothing where there are any openings to the body.<sup>267</sup>

Note that these instructions, written for peacetime accidents on stateside military installations, are generally advisory rather than directive in nature. Given the searing heat and physically exhausting duties being performed, wearing the aforementioned ensemble would have resulted in mass heat casualties in very short order. As it was, personnel working around unexploded ordnance (UXOs) were required to wear flak vests and helmets at all times. Most wore gloves

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<sup>265</sup>Information in sections on "Post-M1A1 Retrograde Radiation Control and Clean up Activity" and "The Final Clean up" is taken from Lead Sheet # 6653, Interview of former US Army Contracting Officer's Representative to ECC, October 31, 1997, and Lead Sheet # 6499, Interview of ECC Contract EOD Team member, October 21, 1997, p. 1-2.

<sup>266</sup>Lead Sheets #5720, Interview of former 11<sup>th</sup> ACR Regimental Engineer, July 7, 1997 and Lead Sheet #5739, Interview of 146<sup>th</sup> Ordnance Detachment (EOD) SSG, July 28, 1997, p. 2.

<sup>267</sup>Guidelines For Safe Response to Handling, Storage, and Transportation Accidents Involving Army Tank Munitions or Armor Which Contain Depleted Uranium, Department of the Army TB 9-1300-278 Washington, DC: Headquarters, Department of the Army, September 1990, paragraph 6-2a, page 6-2.

because they were picking up sun-scorched metal fragments and debris with sharp edges.<sup>268</sup> Even the AMCCOM Radiation Control (RADCON) team wore nothing more protective than cotton overalls, work gloves, and dust masks.<sup>269</sup> Under the conditions described, this level of personal protective equipment (PPE) would have provided substantial protection, especially for inhalation, ingestion, and protection from wounds, while allowing important clean-up operations to continue with maximum efficiency under very stressful conditions.

- **Comments on the Radiation Control Efforts**

Seven of the eight AMCCOM and CECOM team members directly involved in the Camp Doha radiological efforts were contacted for this report, including the heads of both teams. The consensus among the team members was that "we did what we were sent over to do," and that the hazard from DU was negligible outside the immediate vicinity of the tanks. Key members of the ECC team and the Army CORs who assisted and oversaw their efforts have expressed similar beliefs to investigators, and feel that they left behind an uncontaminated site when their efforts were completed.

It is noteworthy that all of the AMCCOM, CECOM, ECC, and 146th Ord. Det. (EOD) personnel who would have been most exposed to any DU contamination in the North Compound have reported that they are in good health. It should also be noted that these individuals (with the exception of 146<sup>th</sup> Ord. Det. members) generally took appropriate precautions and often (but not always) wore half-face respirators, gloves, and similar protective equipment.

In reviewing the overall radiation control response, the following areas raise concerns:

Coordination and support from ARCENT, AMCCOM, CECOM, and Contract personnel.

As log entries and other evidence indicates, ARCENT was aware of the potential hazards posed by Alpha radiation. This information, however, apparently did not reach key leaders and decision-makers at the 11<sup>th</sup> ACR. The 11<sup>th</sup> ACR Engineer Officer was unaware that the AMCCOM team was en route until they "showed up" at Camp Doha. There was little formal coordination and interface between RADCON personnel and the 11<sup>th</sup> ACR leadership, who, if better informed, could have issued better environmental and safety guidance to the troops.<sup>270</sup> Relations between the heads of the AMCCOM and CECOM teams appeared strained, and cooperation between the two teams was limited.<sup>271</sup> 11<sup>th</sup> ACR commanders and decision-makers felt that they were largely disconnected from the radiation-control information loop, since ARCENT was, in effect, "running the show" after the motor pool fire. The reasons for these disconnects remain undetermined, but the net result is that 11<sup>th</sup> ACR soldiers were needlessly subjected to potential DU exposures.

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<sup>268</sup> Lead Sheets #5720, Interview of former 11<sup>th</sup> ACR Engineer Officer July 7, 1997; Lead Sheet #5721, Interview of former 58<sup>th</sup> Combat Engineer Company NCO; July 1, 1997 and Lead Sheet #5732, Interview of former 146th Ord. Det. (EOD) NCO, July 15, 1997.

<sup>269</sup> Lead Sheet #5698, Interview of former AMCCOM team member.

<sup>270</sup> Lead Sheet #5720, Interview of 11<sup>th</sup> ACR Engineer Officer, July 16, 1997.

<sup>271</sup> Lead Sheets #5698, #5699, #5700, and #5997, Interviews of AMCCOM and CECOM members.

Timeliness of the response. The AMCCOM team arrived a week after the blast; the CECOM team arrived almost two weeks later. During the crucial first few days after the blast, the unit leadership and personnel lacked clear, authoritative guidance regarding DU's potential hazard and how it should be handled. This led to unsound practices, such as soldiers picking up spent DU penetrators with their bare hands, and DU penetrators being dumped in an on-base trash pile.<sup>272</sup>

Limited early scope of the effort. Radiation control efforts focused almost exclusively on the M1A1s until the CECOM team arrived on July 24<sup>th</sup>. Contamination from the DU rounds in each tank's magazine had largely been confined to the interiors of the vehicles. However, DU rounds stored elsewhere were also exposed to the fire. DU penetrators not trapped in a burning tank are far more likely to remain intact after the "cook-off" of their propellant. During intense heat, however, some penetrators stored outside the tanks may have burned. There was no concerted effort to assess possible DU contamination from rounds stored outside the tanks until the arrival of the ECC team in mid-September.<sup>273</sup>

Lack of documentation and reporting. Paragraph 1-3c of 1-TB 9-1300-278, the existing guidelines for responding to accidents involving DU, states: "Interim or final written reports will be transmitted through the local Radiation Protection Officer (RPO) to the license RPO within 30 days of the accident or incident. If an interim report is submitted, a final report will be submitted as expeditiously as possible." The CECOM team chief indicated that he submitted daily reports to AMCCOM (now called Industrial Operations Command), but says a final report was never submitted.<sup>274</sup> AMCCOM personnel submitted frequent memos and very brief descriptions of their efforts, but no detailed accounts, complete with daily measurements and written reports, were generated. In the absence of such documentation and other supporting material (daily logs and records, etc.), attempts to quantify possible radiological exposures will remain inexact.

The central question remains: How much DU was actually released into the environment? A precise estimate is impossible, but some key variables have been established. The ammunition stored at Camp Doha constituted the 11<sup>th</sup> ACR's "basic load," or combat requirements. A relatively small number of DU rounds (660) were destroyed or damaged.<sup>275</sup> Of these, about 111 would have been loaded in the three burned-out tanks.<sup>276</sup> Many rounds included in the figure of 660 lost rounds survived the fire without exploding or burning (Figure 44) but had to be removed from the inventory since they had been in a fire.

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<sup>272</sup> Lead Sheet #5720, Interview of 11<sup>th</sup> ACR Engineer Officer, July 16, 1997.

<sup>273</sup> Lead Sheet #5997, Interview of CECOM Team Chief, August 11, 1997.

<sup>274</sup> Lead Sheet #5678, Interview of CECOM Team Chief, August 13, 1997.

<sup>275</sup> "Estimated Cost of Destroyed Ammunition" Army Accident Report 910711001, Fort Rucker, AL: US Army Safety Center, September 20, 1991.

<sup>276</sup> Memorandum for Record, telephone report from SWA Radiation Protection Office, on update of status of Doha accident site, July 18, 1991.

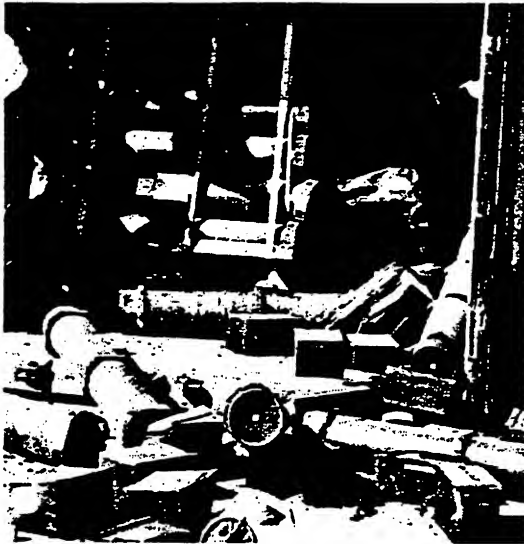


Figure 44 - Unexploded DU rounds

Most of the exposed penetrators recovered at Doha were found intact or nearly intact. Surveys by RADCON teams found no DU contamination outside the North Compound. The heaviest concentration of DU contamination was found in the interiors of the burned tanks. Localized contamination was also found around three of the tanks and several of the burned conexes, however, reports and accounts by RADCON personnel indicated that the levels of radiation here were below even the regulatory guidelines for donning respiratory protection. While several hundred troops could have come into contact with DU rods, fragments, and residual particles in the course of cleaning areas of the 2<sup>nd</sup> Squadron motor pool, the available evidence suggests that these exposures were well below the threshold levels at which health effects might occur.

## ***Tab J - Accidental Tank Fires***

### **• December 1990 Accidental Tank Fire**

The first Operation Desert Shield tank fire occurred on December 5, 1990 and involved an M1 tank from A Co. 3-69<sup>th</sup> Armor, a task force of the 2<sup>nd</sup> Brigade, 24<sup>th</sup> Infantry Division. The tank (bumper number A-66) caught fire in an assembly area north of Main Supply Route (MSR) Cadillac and was completely destroyed.<sup>277</sup> The fire, attributed to ongoing transmission problems, started in the engine compartment. Despite the efforts of the crew to extinguish it, fire spread to the ammunition compartment and the ammunition burned and exploded for 12-14 hours. The crew initially moved 1,500 meters away from the tank, but the possible hazard from the DU rounds prompted them to move away another 800 meters.<sup>278</sup> The radiation-containment (RAD CON) experts from the US Army's Armament Munitions and Chemical Command (AMCCOM) wrote a report saying there was no significant radiological safety hazard to the crew at any time.<sup>279</sup>

AMCCOM sent a three-person team to Saudi Arabia to assist in the survey, the radiological decontamination, and the preparation of the M1 for shipment back to the US. The tank could not be approached until this AMCCOM team, in concert with EOD, ensured that it was safe.<sup>280</sup> While assisting with the clean up the AMCCOM team, headed by the Chief of the Radiological Waste Disposal Division, trained two military health physicists (a captain and a lieutenant). The team arrived at the site of the tank fire on December 15, 1990. Several high-explosive antitank (HEAT) rounds and belts of small arms ammunition were near the tank. After removing several DU penetrators and getting EOD advice, the team exploded the HEAT and small arms ammunition in place. The 24<sup>th</sup> Infantry Division safety officer completed a safety investigation and turned the tank over to the AMCCOM team on December 16, 1990.

The initial radiological survey showed no radiological contamination on the ground around the tank and only a small amount on the tank, near the ammunition compartment. Most of the DU rounds had burned and penetrators and pieces of penetrators were thrown up to 60 feet from the tank. All but five of the 37 DU penetrators were recovered in, around, and under the tank. Several of these recovered penetrators were significantly reduced in size and others were fused to the inside of the hull. The recovery team concluded that the fire consumed the unrecovered penetrators, contributing to the contamination found beneath the tank.<sup>281</sup> AMCCOM shipped

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<sup>277</sup> AR 15-6 Investigation, Investigating Officer's Statement, S-3, 1<sup>st</sup> Bn., 64<sup>th</sup> Armor, undated.

<sup>278</sup> Memorandum for Commander, XVIII Airborne Corps, Subject: "Law and Order Significant Activities (SIGACTS)," December 9, 1990.

<sup>279</sup> Memorandum for Record, Subject: "Trip Report to Saudi Arabia, 3d Company, 69<sup>th</sup> Armored Battalion, 1<sup>st</sup> Brigade, 24<sup>th</sup> Infantry Division, 6-22 December 1990," December 31, 1990.

<sup>280</sup> Memorandum for the Commanding General, Subject: "Status of Collateral Investigation Into Destruction of M1 Tank Assigned to 3/69 AR (Bumper #A66)," December 17, 1990.

<sup>281</sup> Memorandum for Record, Subject: "Trip Report to Saudi Arabia, 3d Company, 69<sup>th</sup> Armored Battalion, 1<sup>st</sup> Brigade, 24<sup>th</sup> Infantry Division, 6-22 December 1990," December 31, 1990.



this contamination and a small amount of sand in a 55-gallon barrel, along with the contaminated tank, to Barnwell, SC. for burial.<sup>282</sup>

In a July 2, 1997 phone conversation, the head of the AMCCOM RADCON team stated that individuals inside the contaminated tank wore protective masks (High Efficiency Particulate Aerosol [HEPA] respirators). He also indicated that the team placed the recovered DU penetrators inside the tank, which was then sealed shut. Finally, the team washed down the tank exterior to remove any contamination prior to shipment (by Heavy Equipment Transporter [HET]) to the port at Dhahran.<sup>283</sup>

- **February 1991 Tank Fire Due to Large Shaped Charge Penetration**

On the evening of February 26, 1991, a large shaped-charge weapon hit an Abrams tank (bumper number B-23) belonging to B Co., 1-37 Armor, penetrating the rear grill doors. The loader was injured when a second round (probably an antitank weapon) struck the tank while the crew was attempting to evacuate. The D Company Executive Officer's tank picked up the crew. The fire from the penetration caused a catastrophic fire in the hull, destroying all stowed DU ammunition. The recovery team found pieces of a Hellfire missile at the site, but investigators never determined whether a Hellfire actually struck B-23. The inside of B-23's turret had no ballistic damage. The tank was recovered on or about March 7, 1991.<sup>284</sup>

- **April 4, 1991 Accidental Tank Fire**

On April 4, 1991 a tank (bumper number D-66) belonging to D Company, 2-34 Armor (a 1<sup>st</sup> Infantry Division task force) caught fire during a tactical road march. The crew frantically discharged 13 hand-held fire extinguishers, but the fire persisted, forcing the crew to move away from the vehicle. The tank continued to burn for 50 hours before two rounds of main gun ammunition (stored in the hull ammunition storage compartment) cooked off. D-66 burned for another 22 hours before EOD personnel could gain access. These EOD personnel and other individuals who may have entered the burned tank could have been exposed to DU. No further information is available regarding the final disposition of the tank.<sup>285</sup>

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<sup>282</sup> Information Paper, Subject: "History and Status of Retrograde of M1 Battle Tank From Saudi Arabia," March 4, 1991.

<sup>283</sup> Lead Sheet #5719, Interview of the former head of the AMCCOM radiation control team dispatched in response to the December 5, 1990 tank fire, July 2, 1997, p. 1.

<sup>284</sup> "Analysis of 1-37 Armor's Battle Damage Incident," Aberdeen Proving Ground, MD: Ballistic Research Laboratory, Undated.

<sup>285</sup> Army Accident Report 910404001, Fort Rucker, AL: US Army Safety Center, printed July 14, 1997.

- **April 13, 1991 Accidental Tank Fire**

On April 13, 1991, a tank (bumper number A-31) from the 2<sup>nd</sup> Brigade of the 1<sup>st</sup> Armored Division was being towed by another tank (bumper number A-32) when the tank rounds aboard A-31 suddenly blew up. High temperatures combined with the tank exhaust from A-32 (the towing tank) probably caused the service rounds to ignite. No crew was on board A-31 at the time of the explosion. The crew of A-32 quickly scrambled to safety, sustaining minor injuries in their haste to distance themselves from the burning tank.<sup>286</sup>

A three-man AMCCOM radiation containment (RAD CON) team flew by helicopter from King Khalid Military City (KKMC), where they were working with DU-contaminated systems, to the site of the tank fire to assess the damage and provide technical assistance. Upon arrival, they observed the tank crew removing all ammunition from the burned A-31. DU and high explosive (HE) rounds were lying on the ground around the tank. Crewmembers were working on the tank, in the ammunition compartment, and on the ground surrounding the tank. Initial readings indicated possible contamination of the tank and surrounding area. More extensive readings confirmed DU contamination on the ground beside the tank, on the front surface of the tank, on the top of the ammunition compartment, and in the ammunition compartment. The RADCON team asked all crewmembers to vacate the tank so they could be radiologically examined. The hands of several crewmembers were contaminated, and one crewmember's coveralls were also contaminated. All individuals were shown how to decontaminate their skin and clothing. All exposed skin was checked for cuts and lacerations. Individuals with open wounds were directed to wash thoroughly. These wounds were also cleaned with Betadine and bandaged. One individual had radiological contamination in an open wound. The wound was thoroughly scrubbed until all traces of contamination were removed.

All crewmembers were issued surgical gloves and masks. The crewmembers and the RAD CON team radiologically examined all equipment removed from the tank in order to separate out the contaminated items. The RAD CON team explained the procedure for washing clothes contaminated by DU and advised the battalion commander to have all exposed personnel shower and wash their clothing as soon as possible. The tank was then transported to the contaminated equipment yard at KKMC.<sup>287</sup>

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<sup>286</sup> Accident Report 910413017, Fort Rucker, AL: US Army Safety Center, printed July 14, 1997.

<sup>287</sup> Memorandum for SRC, AMCCOM-SWA, Subject "Vehicle Assessment Report Depleted Uranium Contamination," May 14, 1991.

## ***Tab K- DU Notification and Medical Follow-up Program***

This Information Paper outlines the program for arranging follow-up medical monitoring and treatment for veterans potentially exposed to depleted uranium (DU) during or following the Gulf War.

### **Background**

On July 8, 1998, the Department of Defense (DoD) and the Department of Veterans Affairs (DVA) will institute a medical follow-up program to evaluate veterans who received the largest DU exposures during the Gulf War. The highest exposures (Level One) occurred during friendly fire incidents in which US combat vehicles were struck by DU munitions fired from US M1A1 tanks. Soldiers riding in or on these vehicles were potentially exposed to DU through fragments embedded in their bodies, inhalation/ingestion of DU particles created upon impact/penetration, and wound contamination. As a result, some soldiers may still retain DU in their bodies. Other soldiers in Level One entered a struck vehicle immediately after it was struck, and could have inhaled or ingested the fine DU particles still suspended in the vehicle's interior. Personnel classified as Level II participants are believed to have received lesser exposures, but still warrant evaluation. These personnel may have been exposed to DU oxides, residues, and fragments while working in or on US vehicles contaminated with DU.

### **Objectives**

Personnel in Levels I and II will be contacted by the Office of the Special Assistant for Gulf War Illnesses for two purposes.

First, the veterans will be informed about the availability of the DoD and DVA depleted uranium medical screening programs and they will be encouraged to enroll in the program for which they are eligible. Also, they will be informed that a follow-up letter will be sent within a week.

Second, the veterans will be asked about their experiences in the friendly fire incidents, or other possible exposures. These data will be used to reconstruct the veterans' possible DU exposure levels. These data will also be used to identify additional personnel who were potentially exposed to DU.

The follow-up program is aimed at ensuring that Gulf War veterans with higher-than-normal levels of uranium in their bodies are identified and given appropriate monitoring and evaluation. It is likely that most soldiers will have normal levels of uranium in their bodies. This program will provide reassurance to them. The program requires a 24-hour urine collection and a detailed medical history in addition to the examination Gulf War veterans receive through the Comprehensive Clinical Evaluation Program or the Department of Veterans Affairs Gulf War Registry. The follow-up will be executed in phases.

## **Implementation**

In Phase I, the pilot program, friendly fire victims contacted by the Office of the Special Assistant for Gulf War Illnesses in October 1997 will be re-contacted and urged to obtain a medical follow-up. The Office of the Special Assistant will send the notification letter at Attachment A, informing veterans of their eligibility for the new medical follow-up program. The notification letter will include the DU Fact Sheet shown in Attachment B.

In Phase II, veterans not previously contacted, but believed to have been in or on vehicles at the time they were struck by DU munitions, will be contacted. Also included in this group are senior leadership from each unit which incurred DU-related friendly fire losses. Phase II will begin on July 15, 1998, and will follow a scenario similar to Phase I, with minor modifications. These soldiers will require a more detailed and flexible notification interview, since some of them were not personally exposed, but may have information regarding soldiers who were. The interview will include questions designed to estimate exposures as well as to identify other soldiers who may have been exposed to DU.

In Phase III, beginning on July 29th, the Office of the Special Assistant will contact other personnel who were possibly exposed to DU. This phase will include personnel who entered DU-contaminated vehicles such as personnel serving in the following organizations or functions: 144<sup>th</sup> Service and Supply Company, Battle Damage Assessment Teams, Logistics Assistance Officers, radiation control teams, and unit maintenance organizations. The Office of the Special Assistant is currently compiling a list of personnel in Phase III. While the medical follow-up protocols and procedures are expected to remain the same for this phase, the information gathering portion of the notification script will be tailored to the specific functions performed by the contacted veterans. By analyzing the medical results from phase I, II, and III veterans, the decision will be made to discontinue notifications, or to add a Phase IV to notify and evaluate veterans with lower exposures.

Some Gulf War veterans have expressed concerns about potential DU exposures, which were at much lower levels than those experienced by the veterans involved in the Level I or Level II categories. For example, some veterans are concerned about potential exposures due to climbing on damaged Iraqi vehicles, or due to being present in the South Compound during the fire at Doha, Kuwait in July 1991. While they are at much lower risk than the veterans in the friendly fire incidents, veterans with these lower exposures may still have questions for their physicians. Veterans in these lower exposure categories will not be identified or contacted by OSAGWI, but they may refer themselves to the DoD or VA for medical advice. If these individuals and/or their physicians believe it is warranted, they will receive a DU medical evaluation.

### **Attachments**

Attachment A	Depleted Uranium Notification Letter
Attachment B	Depleted Uranium Fact Sheet

May 27, 1998



OFFICE OF THE SECRETARY OF DEFENSE  
1000 DEFENSE PENTAGON  
WASHINGTON, DC 20301-1000

SPECIAL ASSISTANT  
FOR  
GULF WAR ILLNESSES

[Veteran's name]  
[Veteran's address]  
[Veteran's address]

Dear [veteran's name]:

Since early 1997, the Office of the Special Assistant for Gulf War Illnesses has been conducting an investigation into the use of depleted uranium (DU) munitions and armor in the Gulf War. As part of that investigation, we recently contacted you about your wartime experiences and DU exposure.

As part of follow-up efforts to ensure that Gulf War veterans who may have had the highest exposure to DU receive appropriate evaluation, the Department of Defense (DoD) and the Department of Veterans Affairs (VA) have instituted a new program to identify, contact, and evaluate the veterans who are believed to have had the greatest risk of coming into contact with DU. This would include veterans who were riding in or on a vehicle that was struck by DU munitions or veterans who entered a struck vehicle immediately after it was hit by DU munitions. Also included are veterans who worked in or on US vehicles contaminated with DU.

Because of your possible exposure to DU, we would encourage you to enroll in this program. The follow-up program is strictly voluntary; however, you are encouraged to participate so that you can be provided with the appropriate medical follow-up should you be found to have a high level of uranium in your body. If you are on active duty, you will be contacted by a DoD representative to schedule an appointment at the closest medical treatment facility. If you are not on active duty, a staff member from the VA will be contacting you to arrange the evaluation at your nearest VA medical center.

We have enclosed a fact sheet describing the potential health effects that may be associated with DU. Please feel free to share this letter and fact sheet with your personal physician, so he or she will know that you may have been exposed to DU. In addition, DoD and VA physicians who perform the CCEP or Gulf War Registry examinations should be able to answer any questions you might have about the impact of DU on your health.

We know that for many veterans the Gulf War is a painful chapter. We are making every effort to ensure that the lessons learned from the war are applied to protect our soldiers. To do this, we need to fully understand the events that occurred in the Gulf, and any health effects that resulted. If you have further information to share with us about your experiences, please contact my office toll-free at 1-800-472-6719 or write to:

Office of the Special Assistant for Gulf War Illnesses  
5113 Leesburg Pike, Suite 901  
Falls Church, Virginia 22041

The health of Gulf War veterans is of utmost importance to us. The DoD and VA are committed to protecting the health of our Gulf War veterans. As we learn more about the impact of the Gulf War on veterans' health, we will continue to keep you informed.

Sincerely,

[signature]

Bernard Rostker

Enclosure



## **DEPLETED URANIUM FACT SHEET**

### **What is Uranium?**

Uranium is a weakly radioactive element that occurs naturally in the environment. Each of us ingests and inhales natural uranium every day from the natural uranium in our air, water, and soil. The amount varies depending upon the natural levels found in the area you live and the levels found in the areas where the food you eat and the water you drink are produced. Consequently, each of us has some level of uranium in our body, which is eliminated in the urine. In areas where the natural uranium level in the soil or water is high, these levels can be substantially higher.

Enriched uranium (uranium that is more radioactive than natural uranium) is used in nuclear power reactors and very highly enriched uranium is used in some nuclear weapons.

### **What is Depleted Uranium?**

Depleted uranium (sometimes known as DU) is uranium that is 40% less radioactive than natural uranium, while retaining identical chemical properties.

The United States Armed Forces used depleted uranium munitions and armor for the first time during the Gulf War. Depleted uranium's ability to protect our soldiers' lives was clearly demonstrated. Depleted uranium is the most effective material for these uses because of its high density and the metallic properties that allow it to "self-sharpen" as it penetrates armor. In contrast, antitank munitions made from other materials (tungsten compounds) tend to mushroom and become blunt as they penetrate. Armor containing depleted uranium is very effective at blunting antitank weapons.

### **What are the health effects of Depleted Uranium?**

The major health concerns about DU relate to its chemical properties as a heavy metal rather than to its radioactivity, which is very low. As with all chemicals, the hazard depends mainly upon the amount taken into the body. It has been recognized that natural uranium at high doses has caused kidney damage. The greatest potential for medically significant DU exposure occurred with those veterans who were in or on tanks and other armored vehicles when the vehicles were hit by DU munitions and in veterans who worked in or on US vehicles or sites contaminated with DU.

Since 1993, the Department of Veterans Affairs has been monitoring 33 vets who were seriously injured in friendly fire incidents involving depleted uranium. These veterans are being monitored at the Baltimore VA Medical Center. Many of these veterans continue to have medical problems, especially problems relating to the physical injuries they received during friendly fire incidents. About half of this group still have depleted uranium metal fragments in their bodies. Those with higher than normal levels of uranium in their urine since monitoring

began in 1993 have embedded DU fragments. These veterans are being followed very carefully and a number of different medical tests are being done to determine if the depleted uranium fragments are causing any health problems.

The veterans being followed who were in friendly fire incidents but who do not have retained depleted uranium fragments, generally speaking, have not shown higher than normal levels of uranium in their urine.

For the 33 veterans in the program, tests for kidney function have all been normal. In addition, the reproductive health of this group appears to be normal in that all babies fathered by these veterans between 1991 and 1997 had no birth defects.

#### **What new program on DU is available?**

As part of follow-up efforts to ensure that Gulf War veterans who may have had the highest DU exposures receive appropriate evaluation and follow-up, DoD and VA have instituted a new program to identify, contact, and evaluate these individuals. This would include veterans who were riding in or on a vehicle that was struck by DU munitions or veterans who entered a struck vehicle immediately after it was hit by DU munitions. Also included are personnel who worked in or on US vehicles contaminated with DU.

#### **What does this involve if I agree to participate?**

If you are on active duty and not enrolled in the Comprehensive Clinical Evaluation Program (CCEP) or if your CCEP examination is over 1 year old, you will receive the standard CCEP evaluation. If your CCEP evaluation is less than 1 year old, your physician will decide what evaluations are clinically required.

All participants will be asked to fill out a brief questionnaire relating to possible exposure to depleted uranium during the Gulf War. In addition, all participants will be asked to provide a 24-hour urine sample – you will be provided a container in which you will collect all of your urine for one day. This urine sample will be analyzed for the presence of uranium.

If you are no longer on active duty, you may enroll in the Gulf War Registry Examination Program at any VA Medical Center. You will be asked to fill out a brief DU questionnaire and provide a 24-hour urine sample for uranium and get a medical examination if you have not already had one or wish to be re-examined.

#### **What does a negative-urine mean?**

It is good news. It means that the level of uranium in your body now is no higher than would be expected from normal intake from natural sources (food, water, and air). It does not mean you were never exposed to DU. It simply means that you have a normal level of uranium in your body now.

## ***Tab L- Research Report Summaries***

This tab provides a summary of some of the major research efforts regarding the military use of depleted uranium. While this listing is not intended to be all-inclusive, it does provide a sense of the depth and breadth of research conducted to date. The studies listed below are summarized on the pages to follow.

Study Number	Description
1	Hanson, Wayne C. <u>Ecological Considerations of Depleted Uranium Munitions</u> , LA-5559. Los Alamos, NM: Los Alamos Scientific Laboratory, June 1974.
2	<u>Environmental Assessment - Depleted Uranium (DU) Armor Penetrating Munitions for the GAU-8 Automatic Cannon, Development and Operational Test and Evaluation</u> , AF/SGPA, April 1975.
3	Elder, J.C., M.I. Tillery, and H.J. Ettinger. <u>Hazard Classification Test of GAU-8 Ammunition by Bonfire Cookoff with Limited Air Sampling</u> , LA-6210-MS, Informal Report. Los Alamos, NM: Los Alamos Scientific Laboratory of the University of California, February 1976.
4	Prado, Captain Karl L. <u>External Radiation Hazard Evaluation of GAU-8 API Munitions</u> , TR 78-106. Brooks Air Force Base, TX: USAF Occupational and Environmental Health Laboratory, 1978.
5	Bartlett, W.T., R.L. Gilchrist, G.W.R. Endres, and J.L. Baer. <u>Radiation Characterization, and Exposure Rate Measurements From Cartridge, 105-mm, APFSDS-T, XM774</u> , PNL-2947. Richland, WA: Battelle Pacific Northwest Laboratory, November 1979.
6	Gilchrist, R.L., J.A. Glissmyer, and J. Mishima. <u>Characterization of Airborne Uranium From Test Firings of XM774 Ammunition</u> , PNL-2944. Richland, WA, Battelle Pacific Northwest Laboratory, November 1979.
7	Davitt, Richard P. <u>A Comparison of the Advantages and Disadvantages of Depleted Uranium and Tungsten Alloy As Penetrator Materials</u> , Tank Ammo Section Report No. 107. Dover, NJ: US Army Armament Research and Development Command, June 1980.
8	Ensminger, Daniel A. and S.A. Bucci. <u>Procedures to Calculate Radiological and Toxicological Exposures From Airborne Release of Depleted Uranium</u> , TR-3135-1. Reading, MA: The Analytic Sciences Corporation, October 1980.
9	Elder, J.C. and M.C. Tinkle. <u>Oxidation of Depleted Uranium Penetrators and Aerosol Dispersal at High Temperatures</u> , LA-8610-MS. Los Alamos, NM: Los Alamos Scientific Laboratory of the University of California, December 1980.



- 10 Chambers, Dennis R., Richard A. Markland, Michael K Clary, and Roy L. Bowman. Aerosolization Characteristics of Hard Impact Testing of Depleted Uranium Penetrators, Technical Report ARBRL-TR-02435. Aberdeen Proving Ground, MD: US Army Armament Research and Development Command, Ballistic Research Laboratory, October 1982.
- 11 Hooker, C.D., D.E. Hadlock, J. Mishima, and R.L. Gilchrist. Hazard Classification Test of the Cartridge, 120 mm, APFSDS-T, XM829, PNL-4459. Richland, WA: Battelle Pacific Northwest Laboratory, November 1983.
- 12 Mishima, J., M.A. Parkhurst, R.L. Scherpels, and D.E. Hadlock. Potential Behavior of Depleted Uranium Penetrators under Shipping and Bulk Storage Accident Conditions, PNL-5415. Richland, WA: Battelle Pacific Northwest Laboratory, March 1985.
- 13 Wilsey, Edward F. and Ernest W. Boore, Draft Report: Radiation Measurement of an M1A1 Tank Loaded with 120-MM M829 Ammunition. Aberdeen Proving Ground, MD: US Army Ballistic Research Laboratory, July 1985.
- 14 Magness, C. Reed. Environmental Overview for Depleted Uranium, CRDC-TR-85030. Aberdeen Proving Ground, MD: Chemical Research & Development Center, October 1985.
- 15 Scherpelz, R.I., J. Mishima, L.A. Sigalla, and D.E. Hadlock. Computer Codes for Calculating Doses Resulting From Accidents involving Munitions Containing Depleted Uranium, PNL-5723. Richland, WA: Battelle Pacific Northwest Laboratory, March 1986.
- 16 Haggard, D.L., C.D. Hooker, M.A. Parkhurst, L.A. Sigalla, W.M. Herrington, J. Mishima, R.I. Scherpelz, and D.E. Hadlock. Hazard Classification Test of the 120-MM, APFSDS-T, M829 Cartridge: Metal Shipping Container, PNL-5928. Richland, WA: Battelle Pacific Northwest Laboratory, July 1986.
- 17 Hooker, C.D. and D.E. Hadlock. Radiological Assessment Classification Test of the 120-MM, APFSDS-T, M829 Cartridge: Metal Shipping Container, PNL-5927. Richland, WA: Battelle Pacific Northwest Laboratory, July 1986.
- 18 Life Cycle Environmental Assessment For the Cartridge, 120MM: APFSDS-T, XM829. Picatinny Arsenal, NJ: US Army Armament Research, Development and Engineering Center, Close Combat Armament Center, December 12, 1988.
- 19 Parkhurst, M.A. and K.L. Sodat. Radiological Assessment of the 105-MM, APFSDS-T, XM900E1 Cartridge, PNL-6896. Richland, WA: Battelle Pacific Northwest Laboratory, May 1989.
- 20 Wilsey, Edward F. and E.W. Bloore. M774 Cartridges Impacting Armor-Bustle Targets: Depleted Uranium Airborne and Fallout Material, BRL-MR-3760. Aberdeen Proving Ground, MD: Ballistic Research Laboratory, May 1989.
- 21 Erikson, R.L., C.J. Hostetler, J.R. Divine, and K.R. Price. Environmental Behavior of Uranium Derived From Depleted Uranium Alloy Penetrators, PNL-5927. Richland, WA: Battelle Pacific Northwest Laboratory, June 1989.

- 22 Fliszar, Richard W., Edward F. Wilsey, and Ernest W. Bloore. Radiological Contamination from Impacted Abrams Heavy Armor, Technical Report BRL-TR-3068. Aberdeen Proving Ground, MD: Ballistic Research Laboratory, December 1989.
- 23 Hadlock, D.E. and M.A. Parkhurst. Radiological Assessment of the 25-MM, APFSDS-T XM919 Cartridge, PNL-7228. Richland, WA: Battelle Pacific Northwest Laboratory, March 1990.
- 24 M.A. Parkhurst, J. Mishima, D.E. Hadlock, and S.J. Jette. Hazard Classification and Airborne Dispersion Characteristics of the 25-MM, APFSDS-T XM919 Cartridge, PNL-7232. Richland, WA: Battelle Pacific Northwest Laboratory, April 1990.
- 25 Kinetic Energy Penetrator Long Term Strategy Study (Abridged), Final Report. Picatinny Arsenal, NJ: US Army Production Base Modernization Activity, July 24, 1990.
- 26 Jette, S.J., J. Mishima, and D.E. Haddock. Aerosolization of M829A1 and XM900E1 Rounds Fired Against Hard Targets, PNL-7452. Richland, WA: Battelle Pacific Northwest Laboratory, August 1990.
- 27 Munson, L.H., J. Mishima, M.A. Parkhurst, and M.H. Smith. Radiological Hazards Following a Tank Hit with Large - Caliber DU Munitions, Draft Letter Report. Richland, WA: Battelle Pacific Northwest Laboratory, October 9, 1990.
- 28 Memorandum for SMCAR-CCH-V from SMCAR, Radiological Hazards in the Immediate Areas of a Tank Fire and/or Battle Damaged Tank Involving Depleted Uranium, Letter Report, Picatinny Arsenal, NJ, December 4, 1990.
- 29 Mishima, J., D.E. Hadlock, and M.A. Parkhurst. Radiological Assessment of the 105-MM, APFSDS-T, XM900E1 Cartridge by Analogy to Previous Test Results, PNL-7764. Richland, WA: Battelle Pacific Northwest Laboratory, July 1991.
- 30 Parkhurst, M.A. Radiological Assessment of M1 and M60A3 Tanks uploaded with M900 Cartridges. PNL-7767. Richland, WA: Battelle Pacific Northwest National Laboratory, July 1991.
- 31 Life Cycle Environmental Assessment for the Cartridge, 105MM: APFSDS-T, XM900E1. Picatinny Arsenal, NJ: US Army Armament Research, Development and Engineering Center, Close Combat Armament Center, August 21, 1991.
- 32 Life Cycle Environmental Assessment For the Cartridge, 120MM: APFSDS-T, XM829A2. Picatinny Arsenal, NJ: US Army Production Base Modernization Activity, February 2, 1994.
- 33 Parkhurst, M.A. and R.I. Scherpelz. Dosimetry of Large Caliber Cartridges: Updated Dose Rate Calculations, PNL-8983. Richland, WA: Battelle Pacific Northwest Laboratory, Reissued, June 1994.
- 34 Parkhurst, M.A., G.W.R. Endres, and L.H. Munson. Evaluation of Depleted Uranium Contamination in Gun Tubes, PNL-10352. Richland, WA: Battelle Pacific Northwest Laboratory, January 1995.

- 35 Parkhurst, M.A., J.R. Johnson, J. Mishima, and J.L. Pierce. Evaluation of DU Aerosol Data: Its Adequacy for Inhalation Modeling, PNL-10903. Richland, WA: Battelle Pacific Northwest Laboratory, December 1995.

#### **Report Number 1**

Hanson, Wayne C. Ecological Considerations of Depleted Uranium Munitions, LA-5559. Los Alamos, NM: Los Alamos Scientific Laboratory, June 1974.

This report concluded that the major ecological hazard from expended DU munitions would be chemical toxicity rather than radiation. Because DU munitions are composed of alloys, the mobility of the DU is substantially decreased compared to uranium. However, the report stated that the chemical toxicity of expended DU to terrestrial ecosystems could not be ignored and must be seriously considered.

#### **Report Number 2**

Environmental Assessment, Depleted Uranium (DU) Armor Penetrating Munitions for the GAU-8 Automatic Cannon, Development and Operational Test and Evaluation, AF/SGPA, April 1975.

This was the Environmental Assessment for the US Air Force's GAU-8 Program. It covered the manufacturing, transportation, storage, use and disposal of GAU-8 ammunition and resulted in a finding of no significant environmental impact.

#### **Report Number 3**

Elder, J.C., M.I. Tillery, and H.J. Ettinger. Hazard Classification Test of GAU-8 Ammunition by Bonfire Cookoff with Limited Air Sampling, LA-6210-MS, Informal Report. Los Alamos, NM: Los Alamos Scientific Laboratory of the University of California, February 1976.

On August 26, 1975, the Los Alamos Lab (under contract to the US Air Force Armament Laboratory, Eglin AFB, FL) tested the GAU-8 ammunition to establish its hazard classification. The new armor-piercing version of the GAU-8 (30-mm) contained a DU core. In addition to "fragment pattern scoring" (the usual objective of a bonfire cookoff test), testers sampled the air to evaluate the potential for airborne DU. One hundred and eighty live GAU-8 rounds were set off in the bonfire cook-off. The test plan did not include the measurement of aerosol size characteristics and mass concentrations:

Analysis of the air sampling data concluded nothing beyond the obvious fact that DU aerosol was released. All but one of the 180 rounds remained within 400 feet of the bonfire. The exception was a shell base. The DU penetrators lost a good deal of mass in the bonfire—about 30% of the penetrators lost visually detectable amounts of DU. The remaining rounds escaped the high temperatures that normally turn DU into aerosol and ash. As the report notes, "Almost total dispersion of several penetrators to aerosol and ash illustrated the probable fate of any penetrator remaining in a high temperature region." In other words, in fires, the potential for DU aerosol dispersion is greater than in other scenarios.

#### **Report Number 4**

Prado, Captain Karl L. External Radiation Hazard Evaluation of GAU-8 API Munitions, TR 78-106. Brooks Air Force Base, TX: USAF Occupational and Environmental Health Laboratory, 1978.

The study concluded that the standards for protection against radiation (10CFR20.105) were met during typical field conditions, provided that: "(1) occupancy of any area 100 cm from any accessible surface of stored CNU-309/E containers by non-occupationally exposed personnel does not exceed a total of 1,000 hours per year, and that (2) the PGU-14/B cartridge is in a case when handled (If the cartridge is handled directly, the total contact time with the projectile surface should not exceed 180 hours per calendar quarter)."

#### **Report Number 5**

Bartlett, W.T., R.L. Gilchrist, G.W.R. Endres, and J.L. Baer. Radiation Characterization, and Exposure Rate Measurements From Cartridge, 105-mm, APFSDS-T, XM774, PNL-2947. Richland, WA: Battelle Pacific Northwest Laboratory, November 1979.

This was one of three studies recommended by the Joint Technical Coordinating Group for Munitions Effectiveness Working Group on Depleted Uranium Munitions in their initial 1974 environmental assessment of DU. This study focused on the health physics problems associated with the assembly, storage, and use of the 105 mm, APFSDS-T, XM774 ammunition. The conclusion of the report was that the "radiation levels associated with the XM774 ammunition are extremely low. The photon emissions measured did not exceed a maximum whole-body or critical organ exposure of 0.26 mR/hr. Even if personnel were exposed for long periods to the highest levels of radiation measured, it is doubtful that their exposure would reach 25% of the maximum permissible occupational dose listed in Title 10 of the Code of Federal Regulations, Part 20."

#### **Report Number 6**

Gilchrist, R.L., J.A. Glissmyer, and J. Mishima. Characterization of Airborne Uranium From Test Firings of XM774 Ammunition, PNL-2944. Richland, WA, Battelle Pacific Northwest Laboratory, November 1979.

This was the last of three studies recommended by the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) in the late 1970s. The purpose of this particular test was to gather data necessary to evaluate the potential human health exposure to airborne DU. (The other two studies were: "Radiological and Toxicological Assessment of an External Heat (Burn) Test of the 105 mm Cartridge, APFSDS-T, XM774" and "Radiation Dose Rate Measurements Associated with the Use and Storage of XM774 Ammunition.") Data collected during this test included the following:

1. Size distribution of airborne DU
2. Quantity of airborne DU
3. Dispersion of airborne DU from the target vicinity
4. Amount of DU deposited on the ground

5. Solubility of airborne DU compounds in lung fluid
6. Oxide forms of airborne and fallout DU

The study included extensive assessment of total and respirable DU levels above the targets and at downwind locations, fallout and fragment deposition around the target, and high-speed movies of the smoke generated by the penetrator impact to estimate the cloud volume. Although technical problems were encountered during the test with filter overload, etc., the following conclusions were drawn:

1. Each test firing generated approximately 2.4 kg of airborne DU.
2. Approximately 75% of the airborne DU was  $U_3O_8$  and 25% was  $UO_2$ .
3. Immediately after the test, about 50% of the airborne DU was respirable, and about 43% of that amount was soluble in simulated lung fluid within seven days. After seven days the remaining DU was essentially insoluble.
4. Particles in the respirable range were predominantly  $U_3O_8$ . Iron and traces of tungsten, aluminum and silicon compounds were found in the airborne particles.
5. The report stated that "Measurement of airborne DU in the target vicinity (within 20 ft) after a test firing showed that personnel involved in routinely changing targets could be exposed to concentrations exceeding recommended maximums. This may have resulted in part from mechanical resuspension of DU from the soil or other surfaces."

Numerous problems were encountered during the sampling for total particulates, which contributed to the conclusion that the average fraction of the penetrator being aerosolized was 70%. These problems included:

- the particulate samplers became clogged and the flow rates dropped to zero which required that the sampling time be estimated,
- the number of fallout trays near the target was inadequate to determine the amount of DU deposited on the ground, and
- the cloud volumes could not be fully evaluated because of inadequate films of the cloud.

Despite the technical problems encountered during the test, 70% is frequently cited as the average level of penetrator aerosolized during hard impact.

#### **Report Number 7**

Davitt, Richard P. A Comparison of the Advantages and Disadvantages of Depleted Uranium and Tungsten Alloy As Penetrator Materials, Tank Ammo Section Report No. 107. Dover, NJ: US Army Armament Research and Development Command, June 1980.

This report provides an excellent history of the logic behind the Army's decision to use DU as a kinetic energy, armored-piercing munition. The final selection of DU over Tungsten was based on a combination of reasons, including the lower initial cost of the penetrator itself and its overall improved performance. DU and Tungsten were rated even for "producibility." Tungsten had the advantage for safety, environmental concerns, and deployment.

**Report Number 8**

Ensminger, Daniel A. and S.A. Bucci. Procedures to Calculate Radiological and Toxicological Exposures From Airborne Release of Depleted Uranium, TR-3135-1. Reading, MA: The Analytic Sciences Corporation, October 1980.

This report provided a description of the models for assessing radiological and toxicological exposures from airborne dispersions of DU under given release conditions—particularly APFSDS-T (Armor-Piercing, Fin-Stabilized, Discarding Sabot-Tracered) XM774 and M735A1 rounds.

**Report Number 9**

Elder, J.C. and M.C. Tinkle. Oxidation of Depleted Uranium Penetrators and Aerosol Dispersal at High Temperatures, LA-8610-MS. Los Alamos, NM: Los Alamos Scientific Laboratory of the University of California, December 1980.

This was an early test to evaluate the consequences of exposing DU penetrators to a variety of thermal conditions ranging from 500°C to 1,000°C in different atmospheres for 2 to 4 hours. The general conclusions of these tests were:

1. DU aerosols with respirable-sized particles are produced when penetrators are exposed to temperatures above 500°C for one-half hour or more.
2. When the penetrators were exposed to sustained fires; forced drafts and temperature cycling enhanced the production of oxide and aerosol.
3. Since the penetrators are not in themselves flammable, complete oxidation required adequate fuel and a fire of more than 4 hours.

**Report Number 10**

Chambers, Dennis R., Richard A. Markland, Michael K. Clary, and Roy L. Bowman. Aerosolization Characteristics of Hard Impact Testing of Depleted Uranium Penetrators, Technical Report ARBRL-TR-02435. Aberdeen Proving Ground, MD: US Army Armament Research and Development Command, Ballistic Research Laboratory, October 1982.

This is the early documentation required by the NRC to support indoor, confined testing of 105 and 120mm kinetic energy DU rounds. NRC initially approved the test firing of 10 rounds to verify the integrity of the test facility; then it approved the firing of 20 DU penetrators to characterize the aerosol generated by a penetrator impact with an armor target. The study contradicted a previous study by Battelle for the XM774, which indicated that up to 70% of the DU penetrator was aerosolized upon impact. During this study, approximately 3% of the penetrator was aerosolized 2-3 minutes after impact, and accounting for error, it was highly unlikely that more than 10% was aerosolized. The test data was consistent with previous test data for small caliber ammunition. For the aerosolized particulates, the mass mean diameter was 1.6 microns and approximately 70% was less than 7 microns, which is considered the upper range of respirable particulates for DU. The study raised many questions concerning the nature of aerosols generated by hard impact testing of DU penetrators.

### **Report Number 11**

Hooker, C.D., D.E. Hadlock, J. Mishima, and R.L. Gilchrist. Hazard Classification Test of the Cartridge, 120 mm, APFSDS-T, XM829, PNL-4459. Richland, WA: Battelle Pacific Northwest Laboratory, November 1983.

The purpose of this test was to determine the behavior of the XM829 cartridge when subjected to (1) detonation of an adjacent XM829 cartridge, and (2) a sustained hot fire. The test concluded that detonating a XM829 cartridge in one container would not cause the immediate detonation of XM829 cartridges in adjacent cartridges. But if a fire starts and continues to burn, adjacent cartridges may ignite, scattering debris up to 40 feet. A mass analysis for the two tests conducted under this project indicated that at least 80% of the cartridge's mass was recovered in the 1982 test and 100% was recovered in the 1983 test. No DU contamination was detected in samples from the sand taken from ground zero. An analysis of the filters from 7 high volume air samplers also indicated that the airborne level of DU remained at natural background levels. The report noted that "great care was taken during this time to prevent the residue from being scattered by winds and that under different conditions these values could vary." An analysis of the respirator canisters also revealed no measurable levels of DU.

### **Report Number 12**

Mishima, J., M.A. Parkhurst, R.L. Scherpels, and D.E. Hadlock. Potential Behavior of Depleted Uranium Penetrators under Shipping and Bulk Storage Accident Conditions, PNL-5415. Richland, WA: Battelle Pacific Northwest Laboratory, March 1985.

The purpose of this test was to characterize the particle size, morphology, and lung solubility of DU oxide samples from 120 mm M829 DU rounds exposed to an external heat test and to conduct a literature search on "uranium oxidation rates, the characteristics of oxides generated during the fire, the airborne release as a result of the fire, and the radiological/toxicological hazards from inhaled uranium oxides."

The test results indicated that a maximum of 0.6% by weight of the DU oxide generated was in the respirable range (i.e., less than 10  $\mu\text{m}$  Aerodynamic Equivalent Diameter) and that the respirable fraction of the oxide was insoluble (i.e., 96.5% had not dissolved within 60 days). The study concluded that DU oxides formed during burning should be classified as insoluble (Class Y-dissolution half-times in the lung of more than 100 days).

### **Report Number 13**

Wilsey, Edward F. and Ernest W. Boore. Draft Report: Radiation Measurement of an M1A1 Tank Loaded with 120-MM M829 Ammunition. Aberdeen Proving Ground, MD: US Army Ballistic Research Laboratory, undated.

This work was supported by the Project Manager, M1A1 Abrams Tank System, US Army Tank and Automotive Command. The tank was loaded with forty M829 120mm rounds to evaluate crew radiation exposure levels. "Preliminary results of the radiation exposures to M1A1 tank

crews were well within the Nuclear Regulatory Guidelines for the general population and there was no undue radiation hazard when the tank was fully loaded with M829 rounds."

#### **Report Number 14**

Magness, C. Reed. Environmental Overview for Depleted Uranium, CRDC-TR-85030, Aberdeen Proving Ground, MD, Chemical Research & Development Center, October 1985.

This is an excellent environmental overview of DU—its relation to natural uranium, its applications (both commercial and military), and its long-term effects on man and the environment. The Army conducted this study to fulfill the relevant background information for Army documentation requirements as detailed in Army Regulation (AR) 200-2.

#### **Report Number 15**

Scherpelz, R.I., J. Mishima, L.A. Sigalla, and D.E. Hadlock. Computer Codes for Calculating Doses Resulting From Accidents Involving Munitions Containing Depleted Uranium, PNL-5723. Richland, WA: Battelle Pacific Northwest Laboratory, March 1986.

The report described the Army's computer modeling to determine whether or not an exclusion zone should be imposed around an accident site, where a boundary should be located, and whether the potential effects farther downwind would be significant or trivial based the characteristics of the incident, the actual munitions involved, and the packaging of the munitions.

#### **Report Number 16**

Haggard, D.L., C.D. Hooker, M.A. Parkhurst, L.A. Sigalla, W.M. Herrington, J. Mishima, R.I. Scherpelz, and D.E. Hadlock. Hazard Classification Test of the 120-MM, APFSDS-T, M829 Cartridge: Metal Shipping Container, PNL-5928. Richland, WA: Battelle Pacific Northwest Laboratory, July 1986.

This was a follow-up test to the Hazard Classification Test summarized in PNL 4459 (Report Number 11 above), which was conducted with a wooden shipping container. This follow-up test was conducted to evaluate a new PA-116 metal shipping container. The results:

1. Igniting a round in a metal shipping container by way of an external source did not cause the detonation of the entire package contents.
2. Ignition of one round surrounded by other rounds did not cause sympathetic detonation of the other rounds.
3. Igniting the cartridges' propellant with a sustained fire caused individual rounds to explode. These explosions caused perceptible blast pressure pulses up to 20 feet away.
4. The individual explosions blew cartridge and shipping container fragments into the air. The penetrators were recovered within 20 feet of the fire. Most of the fragments fell within 200 feet. Two fragments were recovered between 300 to 600 feet from the fire.
5. Four of the 12 penetrators from the fire test showed evidence of oxidation. One penetrator core had oxidized almost completely to oxide powder.



The test also revealed these radiological aspects:

1. About 9.5% of the total DU in the 12 cores was converted to oxide during the fire.
2. The oxide was predominantly  $U_3O_8$ .
3. The fraction of generated oxide that was aerodynamically small enough to be suspended in air and carried by the wind was 0.002 to 0.006 (0.2% to 0.6%).
4. The fraction of generated oxide that was small enough to be inhaled was about 0.0007 (0.07%).
5. The solubility of the DU oxide in simulated lung fluid indicated that 96% was essentially insoluble. Four percent was dissolved in the fluid within 10 days.
6. During the test, winds were relatively calm. "Air monitors (detection limit of  $1\mu\text{g}$  DU) set up to intercept downwind DU aerosol detected no DU on their filters and tended to confirm that there was no significant airborne DU oxide."

The study concluded that, "the minute quantity of oxide that was of respirable size and the calm winds limited the downwind disposal and posed no biological hazard to clean-up crews or others in the area."

#### **Report Number 17**

Hooker, C.D. and D.E. Hadlock. Radiological Assessment Classification Test of the 120-MM, APFSDS-T, M829 Cartridge: Metal Shipping Container, PNL-5927. Richland, WA: Battelle Pacific Northwest Laboratory, July 1986.

This was the follow-up study to a 1983 study evaluating potential health problems when the M829 cartridge is shipped and stored in wooden containers. This follow-up assessment was necessary to evaluate radiation levels when the M829 cartridge is packaged in a metallic container. Results of the study indicate the following:

1. The components of the M829 effectively shield out the predominant nonpenetrating radiation emitted from the bare penetrator; the 1 MeV photons resulting from the decay of the  $^{234m}\text{Pa}$  can penetrate both the components of the projectile and the metal container.
2. The radiation levels emanating from the assembled M829 cartridge are no different from the 1983 study, and the slightly higher radiation measurements at the surface of the package are a function of the reduced distance between the penetrator and the outer package surfaces.
3. The radiation levels associated with the M829 ammunition do not present a significant potential hazard to personnel handling and storing the ammunition.
4. The radiation levels at the surface of the single shipping container, measured with field-use-exposure-rate instruments, do not exceed 0.5 mR/hr, and all other criteria given in 49 CFR 173.421 and 173.424 are satisfied by the M829 shipping package. The package therefore qualifies for shipment as "excepted from specification package, shipping paper and certification, marking and labeling requirements." The inner or outer package must, however, bear the word "Radioactive."
5. The ammunition prepared for shipment must be certified as acceptable for transportation by having a notice enclosed in or on the package, included with the packing list, or

otherwise forwarded with the package. This notice must include the name of the co-signer and the statement, "This package conforms to the conditions and limitations specified in 49 CFR 173.424 for articles manufactured from depleted uranium, UN 2909."

#### **Report Number 18**

Life Cycle Environmental Assessment For the Cartridge, 120MM: APFSDS-T, XM829.  
Picatinny Arsenal, NJ: US Army Armament Research, Development and Engineering Center, Close Combat Armament Center, December 12, 1988.

This was the initial Environmental Assessment (EA) for the M829 armor piercing round. The M829 replaced the XM827 (the American analog of the German DM 13), which was the initial APFSDS-T round. The program included the development and testing of four rounds: Target Practice (M831), High Explosive (M830), Armor Piercing (XM827), and Target Practice (M865). The EA incorporates all of the previous supporting studies on the M829 round (e.g., the radiological and hazard classification of the metal and wooden shipping containers). The conclusion of the EA was a "Finding of No Significant Impact" for the design, production, test and evaluation, deployment, and demilitarization of the M829.

#### **Report Number 19**

Parkhurst, M.A. and K.L. Sodat. Radiological Assessment of the 105-MM, APFSDS-T, XM900E1 Cartridge, PNL-6896. Richland, WA: Battelle Pacific Northwest Laboratory, May 1989.

In this study the XM900E1 round was packaged in the PA-117 steel container. The conclusions of the report are as follows:

1. The components of the XM900E1 effectively shield out the predominant non-penetrating radiation emitted from the bare penetrator and significantly reduce the majority of the penetrating radiation. The 1MeV photons resulting from the decay of  $^{234m}\text{Pa}$  can penetrate both the components of the projectile and the metal canister but are somewhat reduced.
2. Radiation levels associated with the XM900E1 ammunition do not present a significant potential hazard to personnel handling and storing the ammunition.
3. Radiation levels at the surface of the single shipping package, measured with field-exposure-rate instruments, do not exceed 0.5 mR/hr and all other criteria specified by the US Department of Transportation (DOT) in 49 CFR 173.21 and 49 CFR 173.424 are satisfied by the XM900E1 shipping package."

**Report Number 20**

Wilsey, Edward F. and E.W. Bloore. M774 Cartridges Impacting Armor-Bustle Targets: Depleted Uranium Airborne and Fallout Material, BRL-MR-3760. Aberdeen Proving Ground, MD: Ballistic Research Laboratory, May 1989.

This study was one of several conducted on the M774 ammunition (105mm). It addresses only one objective—the documentation of the amount of DU aerosol and fallout around and downwind of the armor-bustle target. “Very little of the depleted uranium of the M774 penetrator left the immediate target area as an aerosol.” The highest value—regardless of the wind conditions—was so low that over 1,400 such tests would have to be fired in a week before tolerance limits would begin to be reached. While the threshold limit value was exceeded when the cloud passed over the samplers, the time-weighted-average exposure for a 40-hour workweek was only 0.07% of the occupational Threshold Limit Value.

**Report Number 21**

Erikson, R.L., C.J. Hostetler, J.R. Divine, and K.R. Price. Environmental Behavior of Uranium Derived From Depleted Uranium Alloy Penetrators, PNL-2761. Richland, WA: Battelle Pacific Northwest Laboratory, June 1989.

This report covers some of the factors affecting the conversion of DU metal to oxide, the subsequent influences on the leaching and mobility of uranium through surface water and groundwater pathways, and the absorption of uranium by growing plants. Although the report is not directly related to the Gulf War, it demonstrates the Army's efforts to understand the environmental fate of uranium.

**Report Number 22**

Fliszar, Richard W., Edward F. Wilsey, and Ernest W. Bloore. Radiological Contamination from Impacted Abrams Heavy Armor, Technical Report BRL-TR-3068. Aberdeen Proving Ground, MD: Ballistic Research Laboratory, December 1989.

The objective of this test was to evaluate DU aerosol levels generated inside and outside a heavy armor Abrams tank (i.e., DU armor) impacted by various types of rounds. The test also evaluated particle size distributions of DU puffs generated by the impact near the point of impact and within 100 meters from the tank, resuspension levels within 100 meters of the tank, and DU contamination in air from a burning M1A1 tank with heavy armor after being hit.

The following types of rounds were used in the seven tests:

1. 120 mm APFSDS, KE - tungsten
2. 120 mm, Heat - MP
3. 100 mm AP-C steel rod
4. Anti-tank Mine
5. 120 mm APFSDS, KE - DU (Test 5A)
6. 120 mm APFSDS, KE - tungsten (Test 5B)
7. Hellfire equivalent

In evaluating the data from the test, it is important to recognize the difference between the aerosols typically generated as puffs from impact and aerosols generated from a fire plume involving DU penetrators. Numerous tests have demonstrated that "DU penetrators when burned in a fire for hazard classification, have formed highly insoluble DU oxides, at least in the respirable size range."

The following permissible exposure levels of uranium in the air and soil were extracted from Table 5 of the report:

Medium	Condition	Less than -	Source
Air	Non-occupational, Soluble U-238	$3 \times 10^{-12}$ $\mu$ Ci/ml (or 192 $\mu$ g/day)	10CFR20, App B Table 2, Column 1
	Occupational, Soluble U-238	$7 \times 10^{-12}$ $\mu$ Ci/ml	Same, Table 1, Column 1
Soil	Unrestricted	35 pCi/gram 97 $\mu$ g/gram	Federal Register, 46, 205, pp. 5261 to 5263, (1981)
Vehicles	Removable contamination for uncontrolled use	Alpha: 450dpm/100 cm <sup>2</sup> Beta: 550dpm/100cm <sup>2</sup>	(AMC) DARCOM 385-1.1-78

Based on the test data, exposures from passing clouds are insignificant beyond 100 meters. The maximum estimated intake at distances greater than 100 meters was 0.82 micrograms of DU. The study noted that it would only take four minutes to reach the airborne limit for the general public, but the passing cloud from each test was present for only a few seconds at a given location. Within 100 meters, but outside the cloud path, air sample results were also insignificant. This included air samplers within 5 to 10 meters of the target. Air sample results in the cloud path varied with the highest level being recorded at a distance of 10 meters from the target (280 micrograms—an acute exposure). There was little additional intake after the puff passed by. Air sampling results for test #6 (a Hellfire equivalent caused a fire that consumed the vehicle) were still within the intake limit even though the air samplers were also exposed to the plume of the fire.

Cascade impactor data for puff of smoke generated at impact revealed that the particles within the cloud were primarily respirable particles (ranging from 76% at the point of impact to 85% just outside the cloud path and 79% along the cloud path). Results of the resuspension air samplers at a distance of 10 to 100 meters from the target revealed that at least for this test, resuspension was not a problem. The highest level recorded was  $1.7 \times 10^{-14}$  microcuries/ml which was well within the limit for airborne uranium.

A personal sampler was worn in the breathing zone by a member of the initial reentry team to evaluate resuspension at the test pad and while climbing inside the crew compartment. All of the resuspension results were within acceptable limits except in Test 6B. For Test 6B, reentry occurred following the fire and the Test 6B sample was collected primarily from inside the crew compartment. The report indicated that a penetrator might have been ejected from one of the storage compartments into the crew compartment and then completely oxidized during the test. Even so, the report cited that the airborne concentration was just above the limit for soluble U-238 and that the limit for insoluble U-238 ( $5 \times 10^{-12}$  microcuries/ml) was probably appropriate. Based on the insoluble U-238 criteria, all resuspension data would be within acceptable limits.

Test data for representative welding operations lasting approximately 20 minutes revealed that exposure levels were above the unrestricted release limits of  $3 \times 10^{-12}$  microcuries/ml of uranium. However, they were never above restricted area limits of  $7 \times 10^{-11}$  microcuries/ml. Local exhaust ventilation was not used for these welding operations and the welding was performed both outside and inside the target, both indoors and outdoors. The report stated that "Even if airborne levels of DU had been above the restricted limit during welding, the welder probably would not have been overexposed. The exposure would be time-weighted to the actual amount of time the welder was working. The usual patchwork took about 20 minutes." However, the welder would still need to wear a respirator under the ALARA guidelines and to protect against other welding hazards such as iron oxide fumes.

For all of the tests, the highest fallout levels occurred on the test pad within 5 to 7 meters of the target. However it was noted that heavy armor material was blown out 76 meters (250 feet) or more from the target after several tests.

Interior air sampling was also taken during the three last impact tests when breakthrough into the crew compartment occurred. Data, though limited, was collected on the first two of those impact events. Data for the last impact was lost because the vehicle caught fire destroying all of the air samplers. During the two impact events in which the penetrators entered through the turret into the main crew area, the air samplers located in the Commander, Gunner and Loader crew positions all shut down during the initial minute following impact. This is probably attributable to either ballistic shock from the impact itself, and/or disruption by the short-lived electromagnetic field, which occurs during armor impact. All of the air samplers placed within the vehicle were small battery powered samplers.

In conducting an assessment of the data it was conservatively assumed that the samplers that shut off did so within the first second after impact. Based on that assumption and knowing the flow rate of the respective samplers, an estimate of intake by an individual was calculated with reference to an inhalation rate of 30 liters per minute (lpm). The maximum mass of DU on a filter in the first breakthrough impact was 3.7 mg DU total dust at the Gunner's position. This equated to a projected intake of 26 mg DU total dust for that second in time. In the second breakthrough impact event, the maximum mass of DU measured on a filter was 4.6 mg DU total dust at the Driver's position. This sampler, however, continued to run until turned off during reentry activities, about 16 minutes after impact. Based on the sampler flow rate and an inhalation

rate of 30 lpm, a projected intake to the driver over that 16-minute period would have been 28 mg DU total dust.

Although the filter for the driver collected 4.6 mg of DU over the 16-minute period, the highest filter reading in the main crew compartment during the event was 2.4 mg, presumably collected in a matter of moments before the sampler shut off. This fact suggests that appreciably higher concentrations of DU might have been collected in the main crew compartment, as opposed to that in the driver compartment, had the sampler not shut off.

Based on the circumstances surrounding each of the two impact breakthroughs for which samples inside the vehicle were collected, significantly higher results would have been predicted for the first impact breakthrough. In the first the turret armor impacted had already been hit on two prior occasions, that may have added to the DU residue inside the tank that was resuspended in the crew compartment at impact. In addition, a DU kinetic energy (KE) round was fired into the armor package during this breakthrough event. In contrast, the round fired for the second event was a non-DU KE round, and the DU turret armor package impacted was impacted for the first time. This discrepancy may be explained by the fact that in the first breakthrough event the vehicle's NBC exhaust air filtration exhaust system was running and the Loader's hatch opened upon impact. In the second breakthrough event, the NBC system was off, and none of the vehicle's hatches opened when impact occurred.

#### **Report Number 23**

Hadlock, D.E. and M.A. Parkhurst. Radiological Assessment of the 25-MM, APFSDS-T XM919 Cartridge, PNL-7228. Richland, WA: Battelle Pacific Northwest Laboratory, March 1990.

The purpose of the study was to assess the health issues associated with the handling, storage and shipment of 25mm, APFSDS-T, XM919 ammunition for the US Army Bradley M3A1 and the US Marine LAV-25. The DU cartridges for the M919 ammunition are packaged in the Army plastic (M-621) and metal (PA-125) shipping containers and the Marine metal (CNU-405) shipping container. The study evaluated radiation levels for shipping containers in storage configurations within and outside the fighting vehicles. The results are as follows:

1. The radiation levels associated with the M919 are low and do not present a significant hazard to personnel handling and storing the ammunition.
2. The radiation levels in the Bradley M3A1 and the LAV-25 are also low. Potential doses to personnel in these vehicles will depend on the length of occupancy in the vehicle and the configuration of the stored munitions.
3. The components of the M919 effectively shield out the predominant non-penetrating radiation emitted from the bare penetrator and significantly reduce the majority of the penetrating photon energy. The one MeV photons resulting from the decay of  $^{234m}\text{Pa}$  can penetrate both the components of the projectile and the plastic M-621 and metal shipping containers but are somewhat reduced.

4. Radiation levels at the surface of the single shipping container and the pallet of 27 shipping containers, measured with field-exposure-rate instruments, do not exceed 2.5 mR/h. The exposure rate is well within the US Department of Transportation's (DOT) special exemption of 2.5 mR/h limit for DU munitions. Therefore, if the Army obtains approval from the Military Traffic Management Command (MTMC), the XM919 shipping container may be shipped under DOT exemption DOT-E96-49. Otherwise, the containers must be shipped under the provisions of 49 CFR 173.425 entitled "Transport Requirements for Low Specific Activity (LSA)."

#### **Report Number 24**

Parkhurst, M.A., J. Mishima, D.E. Hadlock, and S.J. Jette. Hazard Classification and Airborne Dispersion Characteristics of the 25-MM, APFSDS-T XM919 Cartridge, PNL-7232. Richland, WA: Battelle Pacific Northwest Laboratory, April 1990.

Although the 25mm, APFSDS-T M919 cartridge was not used during Desert Shield/Desert Storm, a summary of the Hazard Classification testing is included to demonstrate consistency with previous Hazard Classification tests performed on cartridges used in the Gulf War.

The Hazard Classification Tests performed on the XM919 included the Stack Test which evaluates propagation of detonation and the External Fire Stack Test which evaluates the explosive and fragmentation nature of the cartridge resulting from setting fire to boxes of cartridges. In addition, the M919 was tested against hard armor targets and against wood and masonry to determine the extent and nature of Du aerosols created.

The results of the M919 tests are as follows:

- There was no propagation of initiation demonstrated from the Stack Test. The effects of initiation of the donor cartridge were limited to the donor container. There was no propagation of initiation to the other shipping containers.
- The results of the External Fire Stack Test indicated there was no mass detonation of the cartridges. The cartridges exploded progressively and the effects were limited to the immediate test area.
- Many of the penetrators that remained in the fire showed some signs of oxidation. Approximately 35% of the total DU used in the External Fire Stack Test was oxidized. Between 0.1% and 0.2% of the oxide was within the respirable range. The lung solubility analysis of the DU oxide determined that 92.6% was insoluble and 6.8% was slightly soluble.
- There was no indication that any measurable DU became airborne as a result of the External Fire Stack Test.

- The fraction of DU made airborne from the hard target impact testing was less than 10%. Less than 0.1% of the initial DU penetrator weight was within the respirable size range. About 17% of the oxide present in the smallest size fraction was soluble while the remaining 83% was insoluble.

### **Report Number 25**

Kinetic Energy Penetrator Long Term Strategy Study (Abridged), Final Report. Picatinny Arsenal, NJ: US Army Production Base Modernization Activity, July 24, 1990.

This report addressed battlefield DU exposures relative to peacetime occupational limits. Civilian battlefield exposures are not thought to be significant. "All combat-related internal and external radiation risks were in the range of  $10^{-7}$  to  $10^{-5}$ . The most significant external radiation exposure occurs during the loading and unloading of ammunition lockers, with a lifetime increased cancer risk to the extremities as high as  $3 \times 10^{-4}$  resulting from a worst case, 20-year exposure. Even minimal safety precautions would reduce this risk to levels well below those tolerated in most occupational environments."

The report also addressed the following theoretical exposures;

1. Tank Crew Radiation Exposure Maximum Exposure. Assuming  $\frac{1}{4}$  of a day, seven days/week, 52 weeks/year + .25 rem/year, and a half-filled DU kinetic penetrator ammunition rack, this level is well below the occupational limit of 5 rems/year.
2. Soldier Taking Refuge. Assuming a scenario of a tank hit by a DU penetrator, a soldier taking refuge would receive a maximum exposure of 23 mrem—equivalent to a lifetime increased cancer risk of less than  $5 \times 10^{-6}$ , which is three orders of magnitude less than the lifetime increased cancer risk calculated in the same manner resulting from all background radiation exposures.
3. Major Tank Battle. Assuming a two-month duration, the lifetime increased cancer risk for military personnel would be  $1.5 \times 10^{-7}$ . Downwind of such a battleground, the public would experience a lifetime cancer risk increase of about  $3 \times 10^{-5}$ .

The report also addressed the need for further evaluation of battlefield conditions. "Exposures to military personnel may be greater than those allowed in peacetime, and could be locally significant on the battlefield. Clean-up of penetrators and fragments, as well as impact site decontamination may be required." "Public relations efforts are indicated, and may not be effective due to the public's perception of radioactivity." The Overview also indicated that further studies were needed on DU combat impacts for post-combat briefings and actions.



### **Report Number 26**

Jette, S.J., J. Mishima, and D.E. Haddock. Aerosolization of M829A1 and XM900E1 Rounds Fired Against Hard Targets, PNL-7452. Richland, WA: Battelle Pacific Northwest Laboratory, August 1990.

The purpose of this study was to characterize particulate levels after hard impact with both complete and partial penetration of the armor. Tests were performed with both the M829A1 and XM900E1 rounds, as well as two non-DU rounds (the M865 and DM13). The purpose of the non-DU round firings was to evaluate DU resuspension during hard impact tests. The sample results were questioned when the percent aerosolized was initially estimated to be only 0.2% to 0.5% for the M829A1 and 0.02% to 0.04% for the XM900E1. These values were approximately two orders of magnitude below expected values. A value of 70% has frequently been cited in the popular press based on one of the initial studies performed by Battelle for the XM774. This study stated that it was highly unlikely that more than 10% was aerosolized upon impact. In keeping with other studies indicating that a high percentage of the respirable dust from hard-impact testing was soluble in the lungs, this study's evaluation of the respirable dust fraction indicated that 57 to 76% was class "Y" material and 24 to 43% was class "D" material. (Class "D" materials have dissolution half-times less than 10 days; class "W" materials have dissolution half-times of 10 to 100 days; and class "Y" materials have dissolution half-times greater than 100 days.) The resuspension tests indicated that most of the resuspended dust was non-respirable—which is consistent with the theory that most of the respirable dust was removed by the filtering system in the enclosure.

### **Report Number 27**

Munson, L.H., J. Mishima, M.A. Parkhurst, and M.H. Smith. Radiological Hazards Following a Tank Hit with Large - Caliber DU Munitions, Draft Letter Report. Richland, WA: Battelle Pacific Northwest Laboratory, October 9, 1990.

At the beginning of the Gulf War crisis, Battelle's Pacific Northwest Laboratory was tasked to predict potential radiation hazards to personnel entering a site where a tank has been hit by DU. Their prediction was based on a DU penetrator for a 105-mm, APFSDS-T kinetic energy round striking an armored vehicle and penetrating one side of the vehicle. No live fire testing was performed under this tasking. Their estimates were based on previous tests and their "best educated estimates" of exposures for the following scenario: The vehicle contains no DU munitions or DU armor. The event occurs in a desert-like climate, which exhibits high daytime temperatures and low nighttime temperatures and large fluctuations in relative humidity between inland to coastal areas and from day to night. There are winds associated with the changes in surface temperature. Personnel are in the immediate area for inspections and observation within days after the event. Clean up and recovery activities occur within a few weeks to a few months.

The report stated that the "impact of a DU penetrator with an armored vehicle would be expected to result in aerosolization of 12% to 37% of the penetrator, smearing of DU metal around and through the penetration, and scattering of metal fragments both inside and outside the vehicle. The aerosolized DU would most likely be oxidized uranium and form particulate material which,

depending upon its size, could deposit around the immediate area and preferentially downwind. The material smeared around and through the vehicle penetration would be both DU metal and DU oxide."

The report indicated that exposures to casual passers-by and clean-up personnel would be very low. "Occupational dose limits for external exposure are 5000 mrem/year to the whole body, 50,000 mrem/year to the skin, and 75,000 mrem/year to the hands and feet (extremities). Since the most likely organ to be exposed during contact with penetrator fragments is the skin, it would require over 800 hours of direct contact to bare skin to reach the current occupational limit for skin exposure." Because such direct and long exposure is quite unlikely, the report indicated the radiological hazard from external exposure to DU fragments was very low for causal passers-by and clean-up personnel.

The report stated that the "principal hazard from exposure to DU material is inhalation and lung deposition of particulate uranium. Alpha particle emissions to the lungs from inhaled DU constitute the main health concern from the inhalation of the mostly insoluble DU. Occupational exposure limits for the inhalation of  $^{238}\text{U}$  are  $7 \times 10^{-11}$  microcuries/ml for soluble forms of uranium and  $1 \times 10^{-10}$  microcuries/ml for insoluble uranium compounds. These exposure limits are based on continual intake of  $^{238}\text{U}$  for 13 weeks at 40 hour/week. In terms of mass the limit is an average of  $0.2 \text{ mg/m}^3$  of  $^{238}\text{U}$  aerosols in a 40-h work week."

The report noted that 44% to 70% of the DU material aerosolized would be equal to or less than the 3.3 micrometer Aerodynamic Equivalent Diameter (AED) which is the approximate size that would be inhaled into the deep lung. Characterization of the DU penetrators oxidized in various Hazard Classification testing indicated that 0.2% to 0.6% of the oxide was less than 10 micrometer AED—which is considered as respirable (inhaled into the nasal passages).

The report stated that any hazards from the presence of DU are relatively insignificant as compared to the other battlefield considerations and should not be considered during life saving and rescue activities.

During the recovery operations, the report expressed concerns that the large fragments could pose a potential hazard from external radiation and their surfaces could be a source of uranium oxide contamination as they erode. The report also expressed concern that aerosolized DU which had been deposited in and around the vehicle and on the soil in the immediate area could be resuspended by wind and during clean-up and recovery operations.

The following precautions during general clean up and recovery efforts are quoted from the report:

1. Restrict an area approximately 30 meters in radius from the vehicle to minimize unnecessary exposure to personnel and resuspension of DU material.
2. Perform a radiological survey of the restricted area using a thin window GM portable detector or a micro-R meter.

3. DU metal penetrator fragments detected during the survey should be placed in plastic bags, sealed in a container, and stored as appropriate for disposal.
4. DU oxidized penetrator fragments, identified as a black powder, should be placed in plastic bags and sealed in a container for removal. A small amount of sand around and under the oxidized material may also be contaminated and need to be removed. If piles of oxidized DU are not removed at the time of the survey, it is prudent to fix them in place when detected by covering them with an inverted can or similar mechanism to minimize potential movement.
5. The openings to the interior of the impacted armored vehicle should be closed. The DU penetrator opening and the immediate area around it should also be covered to provide containment and minimize spallation and removal of impacted material. It is assumed that the vehicle will be moved to another location for decontamination and disposition.
6. Intrusion into the restricted area during periods of high winds should be discouraged to minimize potential resuspension of radioactive material.
7. Precautions necessary for entry into the restricted area should depend on the purpose of the entry.

The report also provided general guidance on routine monitoring and decontamination procedures.

1. Radiation dosimeters should not be necessary for survey, vehicle closure, clean up, or recovery activities.
2. Entry for radiological survey of the vehicle's exterior should require no special protective clothing—provided walking over piles of DU oxide is avoided and actions to disturb the soil are minimized.
3. Entry into the interior of the vehicle for any reason should require a single layer of protective clothing, shoe covering, coveralls, gloves, particulate filter respirator and head covering.
4. Entry for pickup of DU fragments and piles of oxide outside the vehicle should require a single layer of protective clothing, shoe covering, coveralls, gloves, particulate respirator, and head covering.
5. Entry to close an opening in the target vehicle should require only gloves for hand protection.
6. After the penetrator fragments and piles of oxide are picked up and the vehicle is closed, entry to remove the vehicle should require no protective clothing.

The transmittal Memorandum recommended that all openings should be sealed and only external surfaces decontaminated in the field. Decontamination of the interior should only be performed in a facility set up for that purpose. The memorandum also recommended limiting intrusion into the clean-up/recovery area during periods of high winds because of the potential for contamination resuspension.

In summary, the report concluded that there is little potential for radiological hazard to personnel entering the site following the impact of a DU penetrator with a tank or other armored vehicle. (The prediction did not assume a DU round impacting an Abrams Heavy Armored vehicle with DU armor.) The report did recommend the use of respiratory protection to minimize the inhalation hazard and decontamination of the body of any fatalities before they are released.

#### **Report Number 28**

Memorandum for SMCAR-CCH-V from SMCAR, Radiological Hazards in the Immediate Areas of a Tank Fire and/or Battle Damaged Tank Involving Depleted Uranium, Letter Report, Picatinny Arsenal, NJ, December 4, 1990.

As noted in Report #27, Battelle's Pacific Northwest Laboratory was tasked to predict potential radiation hazards to personnel entering a site where a tank has been hit by DU. Their prediction was based on a DU penetrator (105mm, APFSDS-T kinetic energy round) striking an armored vehicle and penetrating one side of the vehicle. The report did not evaluate a DU munition impacting an armored vehicle containing DU armor or DU munitions. The December 8, 1990 report comments on the Battelle Letter Report (Report Number 27) and expands the prediction to address DU munitions impacting an armored vehicle containing DU munitions and/or DU armor. Although no live fire testing was performed for this report, the conclusions and recommendations were drawn from BRL Technical Report BRL-TR3068, Radiological Contamination from Impacted Abrams Heavy Armor (Report Number 22 above).

The memo attempted to expand on the guidance included in TB 9-1300-278, "Guidelines for Safe Response to Handling, Storage, and Transportation Accidents Involving Army Tank Munitions Which Contain Depleted Uranium, which was the guideline for responding to peacetime accidents. The memo cited the following points:

- Intrusion into the cleanup/recovery area during periods of high winds should be discouraged due to the potential for unnecessary exposure to DU resuspended by that wind, or by the disturbances caused by people or equipment.
- Other than for decontaminating the outside of the vehicle and covering any openings, as provided in the TB, decontamination of the interior of the tank needs to be performed at a facility set up for such a purpose.
- Removal of deceased personnel from tanks will require radiation safety coordination to determine whether or not the clothing and /or body is radioactively contaminated. If so, decontamination will need to be conducted prior to further disposition of the deceased.
- The procedures in the referenced TB were written for a scenario in where an isolated tank accident involving DU occurred during peacetime conditions. Those same procedures still apply if the scenario were an arena of battle damaged tanks scattered about the surrounding area. In order to properly conduct a recovery/cleanup following the termination of a conflict, one would

begin at the perimeter of that overall area, and gradually work your way in, clean up the immediate area, decontaminate the exterior of that tank, and remove it, before proceeding into the next sector. In other words, don't cross-contaminate or re-contaminate things.

The report also addressed potential problems caused by the sand in Gulf Region and the implication for the Army's standard radiation detection equipment. The report concluded that FIDERS (field instrument for the detection of low energy radiation) would be more appropriate because of their larger probe areas. The report also provided supplemental procedures to TB 9-1300-278 by reiterating the radiation survey precautions cited in the Battelle Letter Report (Report #27).

#### **Report Number 29**

Mishima, J., D.E. Hadlock, and M.A. Parkhurst. Radiological Assessment of the 105-MM, APFSDS-T, XM900E1 Cartridge by Analogy to Previous Test Results, PNL-7764. Richland, WA: Battelle Pacific Northwest Laboratory, July 1991.

Due to administrative restrictions at the test ranges, this study was conducted by analogy to similar test rounds. The conclusions are that "neither propagation of initiation nor mass explosion have occurred with similar large-caliber ammunition, and it is extremely unlikely that either would occur with the M900/PA117" metal shipping container. In a stack fire, the likely extremes with the M900 cartridge are that either all projectiles would be ejected from the fire and show no evidence of oxidation or that all would remain in the fire and totally oxidize. The reality is that some would be ejected from the fire and some would be oxidized. The study cited similar tests for the M735 cartridge, which had maximum fragmentation distances up to 100 feet for the penetrator and 375 feet for the fragments.

#### **Report Number 30**

Parkhurst, M.A. Radiological Assessment of M1 and M60A3 Tanks uploaded with M900 Cartridges. PNL-7767. Richland, WA: Battelle Pacific Northwest National Laboratory, July 1991.

The purpose of the study was to assess the dose rate to which M1 and M60A3 crews would be exposed with the deployment of the 105mm M900 cartridge. The tests were conducted using worst case stowage configurations and placement of the bustle compartment near the driver. All cartridge locations were filled with M900 cartridges, rather than the mix of armor-piercing (M900) and high explosive (HE) cartridges. This is not a likely stowage situation. The dose to a crewmembers was calculated to approximate the actual radiation fields with HE stowed appropriately and taking the place of the excess DU cartridges. The results of the study are quoted as follows:

- Based on this unusual configuration, dose rates peaked in the M1 at 0.5 mR/h under the turret bustle and above the driver's head and in the

M60A3 at 1.5 mR/h in the vertical, exposed cartridge storage rack, as measured by portable radiation detection instrumentation. These levels are within the permissible levels of radiation in unrestricted areas. Using thermoluminescent dosimeters to measure specific points within the vehicle, researchers determined that the M1 commander, gunner, and loader received an average dose rate of about 0.01 mrad/h of penetrating radiation. The driver received an average dose of about 0.2 mrad/h with the bustle above him.

- Dose rates to the M60A3 crew were slightly higher than the dose rates for the M1 crew. The commander and gunner received about 0.05 mrad/h of penetrating radiation. The loader, who had well-shielded cartridges behind him, but a stack of unshielded DU cartridges in front of him, received an average of about 0.2 mrad/h. The driver, who had cartridges on three sides, received an average of 0.28 mrad/h.
- Assuming a crew occupied a fully loaded vehicle for 700-900 hours, none of the crew would be likely to exceed the 250 mrad/year administrative badging limit. Even with DU in all the 105mm ammunition slots, the only person approaching the limit would be the M60A3 driver, and this would only occur if the bustle were over his head during his entire time within the vehicle.
- The study revealed that the drivers of both vehicles had the highest potential exposure. The M1 driver received his entire DU dose from the bustle of cartridges over head. (Note: Most of the time, the gun rather than the bustle is over his head). His dose, measured with the hatch open, maximized the radiation field. Without the bustle, the exposure to the M1 driver is negligible. On the other hand, the driver of the M60A3 gets only a small portion of his exposure from the bustle storage. Most of his exposure comes from storage in the hull.
- The study estimated that dose rates for more ordinary configurations are less than 0.05 mrad/h for the M1 driver and about 0.1 mrad/h for the M60A3 driver.

### **Report Number 31**

Life Cycle Environmental Assessment for the Cartridge, 105MM: APFSDS-T, XM900E1.  
Picatinny Arsenal, NJ: US Army Armament Research, Development and Engineering Center,  
Close Combat Armament Center, August 21, 1991.

This Environmental Assessment was developed to address environmental concerns when the service round for the M68 cannon on the M60A3 and M1 tanks (the M833 APFSDS-T) was replaced by the new XM900E1 APFSDS-T round, which has significantly greater armor-piercing capabilities. The Assessment included previous studies of the radiological hazards, etc. conducted on the XM900E1. The Assessment's conclusion was that only the testing modes for armor penetration and accuracy and final disposal of the penetrators presented any significant potential for environmental impact; the report outlined mitigating measures to reduce the impact

of testing. From a health and safety standpoint, the XM900E1 presents no greater risk than the existing M833. The XM900E1 program is not expected to have a significant environmental impact on air quality, water quality, ecology (flora and fauna), or health and safety to personnel associated with normal maintenance and life cycle operations.

### **Report Number 32**

Life Cycle Environmental Assessment for the Cartridge, 120MM: APFSDS-T, XM829A2.  
Picatinny Arsenal, NJ: US Army Production Base Modernization Activity, February 2, 1994.

This is an environmental assessment (EA) of the third generation M829 round (M829A2). It builds on the EA for the previous M829 and M829A1 rounds (see Report Number 18) and concludes with a "Finding of No Significant Impact." This assessment excludes combat uses and fires or other severe and unlikely accidents and the testing modes for armor penetration and accuracy. The EA recognized that the resuspension of DU, environmental transport, and various health and safety issues as areas of concern requiring further evaluation. Consequently, the Army Environmental Policy Institute has been tasked to evaluate the risks associated with depleted uranium left on the battlefields during Desert Storm. In addition, studies on the health effects of DU fragments in soldiers have been funded. The Army is also developing special DU training courses for personnel engaged in fielding, firing, and retrieval operations.

### **Report Number 33**

Parkhurst, M.A. and R.I. Scherpelz. Dosimetry of Large Caliber Cartridges: Updated Dose Rate Calculations, PNL-8983. Richland, WA: Battelle Pacific Northwest Laboratory, June 1994.

This report provides revised exposure levels for all of the previous radiological assessments performed by Pacific Northwest Laboratory (PNL) that used the lithium fluoride thermoluminescent dosimeter (TLD). PNL developed a new, more accurate algorithm for interpreting the response of the TLD used in the radiological assessment of various DU cartridges. As a result, PNL re-evaluated the previously reported exposure values for the following cartridges:

1. 120 mm M829 cartridges
2. 105 mm M333 cartridges
3. 120 mm M829A1 cartridges
4. 120 mm M829A2 cartridges
5. 105 mm M900 cartridges
6. M60A3 and M1 Tanks loaded with M900 cartridges.

The report also provides a comparison of the original versus recalculated values. "In all cases, the recalculated dose rates were significantly lower than the originally reported dose rates. Studies of dose rates in the tanks showed that crews in tanks loaded with DU rounds would pose no danger of exceeding administrative badging limits of 250 mrem/year and it was also unlikely that the more restrictive population limits of 100 mrem/year would be exceeded by personnel in the tanks." In other words, radiation exposure levels associated with uploaded DU munitions in the applicable tanks are within acceptable criteria, even for the general population.

All of the previously reported radiological assessment reports need to be corrected to reflect the results of the recalculations.

#### **Report Number 34**

Parkhurst, M.A., G.W.R. Endres, and L.H. Munson. Evaluation of Depleted Uranium Contamination in Gun Tubes, PNL-10352. Richland, WA: Battelle Pacific Northwest Laboratory, January 1995.

Routine radiation monitoring identified radiological contamination in gun tubes that fire developmental and production DU rounds. This report addresses the issues of how much DU is present in tubes that have fired DU, how this relates to unrestricted release standards, how cleaning techniques reduce the DU levels, and how the levels relate to personnel radiation protection.

Testing revealed that numerous tubes had detectable levels of DU in the gun barrels and some were above the unrestricted release limits, but none were high enough to pose a health risk. Firing non-DU training rounds is also effective in reducing the contamination in the tubes, but the practice is not recommended. The removable contamination makes up only a small percentage of the DU contamination that is generated in the firing process. The fixed contamination that is left behind after normal barrel field cleaning procedures was found in a number of instances to be above uncontrolled release limits. Presently, unless more satisfactorily decontaminated by other cleaning means, those barrels would have to be processed as radioactive waste at the time of turn in by the field of the barrel for disposal. Further studies were required to fully assess the problem. Induced flareback was also achieved during firing to determine if tank personnel were exposed in the turret, but no problems were identified for crew personnel.

#### **Report Number 35**

Parkhurst, M.A., J.R. Johnson, J. Mishima, and J.L. Pierce. Evaluation of DU Aerosol Data: Its Adequacy for Inhalation Modeling, PNL-10903. Richland, WA: Battelle Pacific Northwest Laboratory, December 1995.

As the name of the report implies, the purpose of this study was to evaluate the existing research data on the characteristics of DU aerosols generated under various conditions. The report is an excellent summary of the studies conducted to date, including many summarized in this report. Project summaries were included for over 20 studies conducted by Battelle Pacific Northwest Laboratory and over 20 additional studies conducted by other researchers. The evaluation focused on chemical composition, particle size, and solubility in lung fluid.

Although several areas such as resuspension and particle size distribution were cited as needing further research, the overall quality of the data was deemed as being adequate to make conservative estimates of dispersion and health effects. The report is an excellent summary of the studies conducted to date.



## ***Tab M- Characterizing DU Aerosols***

The actual level of aerosols generated during the various impact tests has varied widely. One of the first hard impact tests conducted on DU ammunition was reported in *Characterization of Airborne Uranium from Test Firings of XM-744(sic) Ammunition*, 1979.<sup>288</sup> This report concluded that as much as 70% of the 105mm penetrator would turn into aerosol upon impact. Although this 70% has been frequently cited, it is flawed and misleading—mainly because it was “back-calculated” from cloud data and represented a worst-case scenario (i.e., an impact against a hard target, which was not penetrated). The 1982 report from the Ballistic Research Laboratory entitled *Aerosolization Characteristics of Hard Impact Testing of Depleted Uranium Penetrators* contradicted the results of the 1979 test. In this test, about 3% was aerosolized 2-3 minutes after impact. Allowing for error, it is highly unlikely that more than 10% of the penetrator was aerosolized in the 1982 test. The 1982 test found that 70% of the aerosolized particles were less than 7 microns—i.e., respirable particles.<sup>289</sup>

Hard impact testing in 1990 of the M829A1 120mm cartridge and the XM900E1 105-mm cartridge produced somewhat contradictory numbers. This study characterized particulate levels after hard impact with both complete and partial penetration of the armor. The tests were performed with both the M829A1 and XM900E1 rounds, as well as two non-DU rounds, the M865 and DM13. (The purpose of the non-DU round firings was to evaluate DU resuspension during hard impact tests.) The sample results were questioned when only about 0.2% to 0.5% of the DU was aerosolized for the M829A1 and 0.02% to 0.04% for the XM900E1. (These values were approximately two orders of magnitude below expected values.) After comparing Real-Time Aerosol Monitor (RAM) data with RAM data from a previous test, researchers eventually estimated that the percent aerosolized was closer to 18%—substantially less than the 70% previously cited by Battelle in the 1979 test. The respirable aerosol fraction [less than 10  $\mu$ m AED (Aerodynamic Equivalent Diameter)] was 91% to 96% for the M829A1 and 61% to 89% for the XM900E1. Evaluation of the respirable dust fraction indicated that 57% to 76% was class “Y” material and 24% to 43% was class “D” material, in keeping with other studies which indicated that a high percentage of the respirable dust from hard impact testing was soluble in the lungs. (Note: Class “D” materials have dissolution half-times less than 10 days, class “W” materials have dissolution half-times of 10 to 100 days and class “Y” materials have dissolution half-times greater than 100 days.)<sup>290</sup> The resuspension tests indicated that most of the resuspended dust was non-respirable, which is consistent with the theory that most of the respirable dust was removed by the filtering system in the enclosure. The aforementioned tests are but a few of the tests performed on DU munitions in an attempt to characterize aerosol formation and assess potential exposures. As a result of recommendations made in the 1995

<sup>288</sup> J.A. Glissmeyer, J. Mishima, and R.L. Gilchrist, *Characterization of Airborne Uranium from Test Firings of XM-744(sic) Ammunition*, PNL-2944, Richland WA: Battelle Pacific Northwest Laboratory, 1979.

<sup>289</sup> Dennis R. Chambers, Richard A. Markland, Michael K. Clary, Roy L. Bowman, *Aerosolization Characteristics of Hard Impact Testing of Depleted Uranium Penetrators*, Technical Report ARBRL-TR-023435, Aberdeen Proving Ground, MD: Ballistic Research Laboratory, October 1982, p. 46.

<sup>290</sup> S.J. Jette, J. Mishima, and D.E. Haddlock, *Aerosolization of M829A1 and XM900E1 Rounds Fired Against Hard Targets*, PNL-7452, Richland, WA: Battelle Pacific Northwest Laboratory, August 1990, p. 4.1.

*Health and Environmental Consequences of Depleted Uranium Use in the US Army: Technical Report*, Battelle's Pacific Northwest Laboratory conducted an evaluation of existing test data for predicting aerosol exposures. Their report (entitled *Evaluation of DU Aerosol Data: Its Adequacy for Inhalation Modeling*) identified some of the technical problems with estimating exposure under various combat scenarios. The following is a brief discussion of DU aerosol generation scenarios present in the report.<sup>291</sup>

- Fires. During a munitions "cookoff," the burning propellant does not consume oxygen since the propellant supplies its own oxygen. Little if any oxidation of the DU metal occurs because combustion is so rapid. Studies have shown that few of the particles generated during a fire are small enough to be caught up in the thermal currents unless there are violent explosions. The solubility of the oxides formed during a fire are low. Most of the particles produced in a tank fire end up deposited on the interior walls of the tanks, but openings (hatches, holes created by explosions, etc.) could let particles out into the surrounding atmosphere.
- Vehicles Punctured by Projectiles. As noted in other studies, the level of oxides formed during impact is largely a function of the "hardness" of the target. The heavier the armor, the more oxides that will be formed as the DU penetrator expends its kinetic energy "burning" through the armor. During the Gulf War, there were numerous DU hits on lightly armored vehicles, which typically left round, golf-ball-sized entrance and exit holes. Because lightly armored vehicles offered little resistance, unless the round struck the engine or similar obstructions, DU aerosolization was limited in these cases. Conversely, harder targets (like Abrams M1A1 Heavy Armor tanks involved in friendly fire incidents) tend to produce higher levels of DU aerosolization. Aerosolization is enhanced if the penetrator splits into fragments and those fragments remain inside the vehicle. Aerosol levels inside the vehicle also depend on such factors as the number of open hatches and other ruptures or openings. Eventually, particles from inside the tank are either deposited on the inside surfaces of the tank or released to the atmosphere through any opening. As particles are deposited on the interior surfaces, the particle size, distribution, and mass change.
- Entry of Contaminated Vehicles. For Battle Damage Assessment Team (BDAT) personnel, recovery personnel, or souvenir hunters entering the damaged vehicles, the primary concern is resuspension of DU dust. Resuspension depends on the air turbulence inside the vehicle and other conditions (e.g., oily surface walls minimize resuspension). Physical activity inside the vehicle (like lifting or moving equipment or personnel) would obviously increase the level of resuspension. For emergency rescue personnel who enter the tank shortly after impact, the aerosols generated at impact would be the primary concern. These impact aerosol levels should be higher

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<sup>291</sup> M.A. Parkhurst, J. R. Johnson, J. Mishima, J.L. Pierce, Evaluation of DU Aerosol Data: Its Adequacy for Inhalation Modeling, PNL-10903, Richland, WA: Battelle Pacific Northwest National Laboratory, December 1995, p. 2.4-2.6.

than the resuspension levels generated after the aerosols in the tank have had time to settle or to be vented through open hatches, etc.

- Inspection and Repair Activities on Contaminated Vehicles. Entry into contaminated vehicles for inspection and repair activities can cause significant DU resuspension. And some of the actual repair activities—like cutting and welding—have the potential to raise resuspension levels even higher. Cleaning operations can also cause resuspension.
- Routine Combat Activities. The report, *Evaluation of DU Aerosol Data: Its Adequacy for Inhalation Modeling*, also indicated potential exposures from DU penetrators that did not penetrate the target or were deflected. The penetrator would be hot enough to generate aerosols, so oxides would continue to be formed for a while once the penetrator was buried in the soil. The report also cited potential exposure to troops near the target at impact, or troops exposed to resuspension from subsequent activities on, in, or near the target.

Two recent tests conducted after the Battelle Summary report raise some questions concerning the nature and extent of respirable particulates generated during fires and hard impact testing. In June 1995, the Army fired 120 mm and 25 mm DU munitions against Soviet armored equipment. Although technical and procedural difficulties seriously affected the data and limited the conclusions that could be drawn from the test, several key findings were cited in the Draft report. They were:

- DU aerosols, containing particles of respirable sizes, are generated inside armored vehicles by DU penetrator impact. The concentration of airborne DU aerosol decreases with time, but measurable concentrations of respirable particles remain suspended hours later.
- Measurable quantities of DU oxide particles that settle on surfaces can be resuspended during routine personnel re-entry activities, and that the resuspended aerosols contain particles of respirable sizes.<sup>292</sup>

The second test was the 1994 burn test of a Bradley Fighting Vehicle (BFV) equipped with TOW anti-tank missiles and 1,125 M919 25mm cartridges. This was the first time that a vehicle with a full combat load of DU munitions was actually used in a burn test. Most of the previous data for fires were generated from stack testing wooden or metal shipping crates. The BFV was completely engulfed by the fire and burned vigorously for about an hour. The fire subsided after an hour, but continued to emit a plume over the next five hours with smoldering hot spots into the next day.<sup>293</sup> Of the 1,125 DU penetrators, 625 were accounted for, including nine live rounds found within a few meters of the test pad. Although 500 rounds were unaccounted for, the report indicated that a large percentage was trapped within the melted remains and a significant amount

<sup>292</sup> Draft Depleted Uranium (DU) Hard Impact Aerosolization Test Summary Report (Source Term and Resuspension Estimates), EAI Report A010/96/001D1, U.S. Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ, October 1996.

<sup>293</sup> M.A. Parkhurst, M.H. Smith, and J. Mishima, Bradley Fighting Vehicle Burn Test. Final Draft Report, Richland, WA: Battelle Pacific Northwest Laboratory, October 1997, p. 6.1.

of the DU oxide was mixed within the ash and settled inside and around the hull of the vehicle. Six piles of DU oxide were detected on the vehicle surface after the fire. Analysis of the DU oxide indicated that approximately 33% of the oxide particulates were respirable. However, only trace amounts of DU oxide were detected on the air monitoring filters at various distances during the 29 hours of air sampling.<sup>294</sup> Although the higher percentage of respirable particulates (33%) measured in the piles of DU oxide after the fire is an important consideration for assessing resuspension potential during recovery, however, further research is needed to determine whether the higher values of respirable particulates were unique to this test or if results are truly valid for vehicle fires involving DU munitions.

<sup>294</sup> M.A. Parkhurst, M.H. Smith, and J. Mishima, Bradley Fighting Vehicle Burn Test. Final Draft Report, Richland, WA: Battelle Pacific Northwest Laboratory, October 1997, p. 6.1-6.5.

## ***Tab N – Summary of Health Estimates***

Health risk assessments for 13 identified exposure events are being prepared that describe the activities of the participants, specify the sources of potential DU exposure, and estimate the dose from inhalation, ingestion and wound contamination, as appropriate for each exposure category. The US Army Center for Health Promotion and Preventive Medicine (CHPPM) is conducting these exposure assessments. These assessments will incorporate information from a RAND Corporation review of the current understanding of health effects associated with DU. These will be described in plain language by CHPPM. Most of the health risk-related studies are currently in progress.

This tab summarizes the exposure assessment information prepared by CHPPM for the Level I participants inside combat vehicles as they were struck by DU. Activities of these participants are described, hazards assessed, and exposure assessment (chemical and radiological) and dose response information is reviewed, along with a summary of the risk characterization reflecting the current body of knowledge.

### **LEVEL I**

Level I soldiers, injured or not, were in or around combat vehicles at the time they were struck by DU sabots, or immediately afterward. Besides the embedded fragments from wounds, these individuals may have inhaled DU aerosols generated by fires or by the impact of the DU projectile penetrating the target. The following discussion briefly summarizes the activities of Level I participants and provides pertinent details such as types of vehicles involved and the circumstances under which they were mistakenly targeted by US tank crews. For a more in-depth discussion of the incidents described, please see TAB H.

Level I participants are separated into two categories: soldiers who were in or on combat vehicles at the time they were struck by DU rounds; and soldiers who entered those vehicles immediately afterwards to rescue wounded comrades. The former group is currently believed to have incurred the highest risk from embedded DU fragments and/or inhalation of the DU aerosols resulting from penetrator impact.

#### **1. Occupants of Vehicles When Struck**

##### **a) Summary of Activities**

Armor crewmen and the "dismounted" infantry transported in M2/M3 Bradley Fighting Vehicles supplied the offensive striking power for Operation Desert Storm. The highly mechanized US armored and mechanized infantry units counted on the speed, mobility, and firepower of their Bradleys and Abrams to maintain a rapid rate of advance while engaging and neutralizing enemy formations who tried to block Coalition troops from achieving their objectives.

b) Hazard Identification:

The activities of Level I vehicle occupants indicate that the combinations of personnel location, form of contamination, and route of exposure shown in Table 8 were possible. Additional details of the scenarios and assessments will be contained in the CHPPM risk assessment paper when published. Members of this group were potentially exposed through all possible routes of entry, including wounds.

Table 8 - Potential Hazards to Occupants of Struck Vehicles.

Location	DU Form	Route of Exposure
Inside Vehicle	Metal Fragment	Wound
	Soluble and Insoluble oxides	Inhalation
		Ingestion
		Wound Contamination

Occupants of the vehicles were subjected to wounds from flying fragments, inhalation of airborne soluble and insoluble DU aerosols, ingestion of soluble and insoluble DU residues by hand-to-mouth transfer, and contamination of wounds by contact with contaminated clothing and vehicle interiors.

c) Dose Assessment

Soldiers in or on vehicles struck by DU munitions were possibly exposed through four routes: direct wounding, inhalation, ingestion, and contamination of wounds. Individuals with direct wounds who retained fragments of DU are currently being evaluated in the DU Follow-up Program. The remaining participants in this category could have been exposed to inhalation, ingestion, and wound contamination whether DU penetrated the crew compartment or not.

Many variables must be considered when estimating the dose received by these individuals. A basic approach, however, involves consideration of test data produced under conditions similar to the scenarios being evaluated. For Level I participants, USACHPPM reviewed over 80 published reports. The characteristics of DU oxide particles, such as chemical composition, particle size, isotopic composition, equilibrium of progeny, and solubility in lung fluid, were identified and considered. These show:

- That fires produce DU oxides that are mostly insoluble;
- That DU impacts on armor produce oxides that are somewhat more soluble; and
- That monitoring data from tests may be used when conditions of the test are the same as the conditions of the case being evaluated.

CHPPM's preliminary review of the test data allowed estimates of the airborne DU inside heavy armor M1A1 tanks to be determined for three scenarios: 1) the upper bound (worst case) (maximum air sample observed) exposure when one DU penetrator enters the crew compartment

of a heavy armor M1A1, 2) the most likely (average air sample observed) exposure when one DU penetrator enters the crew compartment of a heavy armor M1A1, and 3) the average (most likely) exposure when one DU penetrator strikes a heavy armor M1A1 but does not enter the crew compartment.<sup>295</sup> Using the test data for DU penetrators impacting on DU armor is considered to be a conservative approach because no penetrations of DU armor were noted for the friendly fire incidents during the Gulf War. However, in several cases, non-DU armor was penetrated by more than one DU round. Since Bradley Fighting Vehicles have much lighter armor than Abrams tanks, penetrations by DU normally produce less aerosol. However, there is not enough data at this point to provide a reliable estimate for Bradley penetrations. Therefore, the data for single and multiple penetrations of an Abrams Heavy Armor tank are considered to represent a worst case.

A review of the test data shows that concentrations of DU in the air under the two scenarios for the DU penetrator entering the crew compartment, with an estimated stay time of 15 minutes and standard breathing rates, yield an estimated maximum intake of 26 milligrams (mg) of DU and an average intake of 12 mg from a single DU penetrator hit. When the DU penetrator did not penetrate the crew compartment the intake was 0.042 mg or 42 micrograms ( $\mu\text{g}$ ) or almost a thousand times less than when the penetrator enters the crew compartment.

The medical significance of these exposures is discussed below under dose response and risk characterization. It is important to realize that these estimated intakes of 26 mg, 12 mg, and 0.042 mg are for total DU oxide. If the intakes are then converted to radiation doses using the Lung Dose Evaluation Program (LUDEP), a lung dosimetry computer modeling program, CHPPM's estimate of the radiation doses were 0.48 rem (maximum), and 0.23 rem (average) when the penetrator entered the crew compartment; and 0.0005 rem when there was no entry of the crew compartment. For two hits, the intakes were doubled to 52 mg, 24 mg, and 0.084 mg, respectively, which produced radiation doses of 0.96 rem, 0.46 rem, and 0.001 rem.

To evaluate the heavy metal dose, the total DU oxide was divided between soluble and insoluble components. Based on the results of the solubility analysis of the DU oxide (83% insoluble and 17% Class D soluble), CHPPM's estimate of the intake values for a single DU penetrator hit were 22 mg insoluble/4 mg soluble, 10 mg insoluble/2 mg soluble, and 0.035 mg insoluble/0.007 mg soluble for the three cases.<sup>296</sup>

For the ingestion route of exposure for individuals who were in the vehicle when a single DU penetrator entered the crew compartment, intake by hand-to-mouth transfer was estimated to be 16 milligrams of DU based on measured surface contamination levels, estimates of the hand to mouth transfer factors, and the assumption that 83% of the intake was of the insoluble "Y class"

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<sup>295</sup> Fliszar, Richard W., Edward F. Wilsey, and Ernest W. Bloore. Radiological Contamination from Impacted Abrams Heavy Armor, Technical Report BRL-TR-3068, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, December 1989.

<sup>296</sup> Memorandum for the Office of the Special Assistant Secretary for Gulf War Illnesses, Subject: Program Summary, USACHPPM Assistance with OSAGWI's Depleted Uranium (DU) Environmental Exposure Report, August 3, 1998.

and 17% of the intake was of the soluble "D class". This intake results in an estimated radiation dose equivalent of 0.000002 rem. For two hits, the intake and associated radiation dose are 32 mg and 0.000004 rem.

Estimates of the intakes from DU contamination of wounds are continuing. This is primarily caused by the gaps in the available data on transfer of contamination from surfaces to wounds. Estimates of the intakes from this route are expected to be included in a follow-up version of this report.

#### d) Dose Response

The medical effects literature on depleted uranium was reviewed by RAND and will be discussed in their forthcoming report. Their preliminary review indicates that for the level of radiation exposure from depleted uranium in the Gulf War cancer and genetic effects are the main concern. Scientific studies have shown that these effects occur with a total incidence of  $7.3 \times 10^{-4}$  per rem.<sup>297</sup>

#### e) Risk Characterization

##### 1) Radiation risk.

The exposure for Level I individuals (excluding those with embedded DU fragments) inside an Abrams M1A1 tank when a DU penetrator enters the crew compartment, is conservatively estimated to be 0.48 rem for a 15 minute exposure from a single DU penetrator or 0.96 rem from two DU penetrators. Using the dose response factor of  $7.3 \times 10^{-4}$  per rem, the combined risk for all fatal cancers, non-fatal cancers, and genetic effects is 0.0007 (which is determined by multiplying  $7.3 \times 10^{-4}$  medical effects per rem by 0.96 rem = .0007). This should be considered an upper limit for the worst case involving two DU penetrators. This estimate is preliminary and will be refined as more data become available.

For comparison, the average radiation exposure to a member of the US population from background radiation is 0.3 rem per year.<sup>298</sup> So this maximum estimated exposure of 0.96 rem is about the same as living in the United States for about three years and is less than one-fifth of the annual limit for workers of 5 rems.

When the crew compartment was not penetrated, the estimated dose (0.001 rem) is much smaller; the same as the radiation exposure from one day of background radiation.

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<sup>297</sup> Memorandum for the Office of the Special Assistant Secretary for Gulf War Illnesses, Subject: Program Summary, USACHPPM Assistance with OSAGWI's Depleted Uranium (DU) Environmental Exposure Report, August 3, 1998.

<sup>298</sup> Exposure of the Population of the United States and Canada from Natural Background Radiation, Report No. 94, NCRP (National Council on Radiation Protection and Measurements), Bethesda, MD, 1987.



Another way to describe the effects on health is by calculating a person's increased probability of experiencing the effects (dying from cancer, contracting other cancer, or producing genetic effects in future generations). For the maximum case above, the probability is 0.0007. This means that the exposed person would experience an increased chance of 1 in 1,427 of experiencing the effect.<sup>299</sup> For comparison, the chance of dying from **all** causes of cancer during his or her lifetime is 23% (1 in 4.3); or about 300 times higher than the highest estimated risk from DU. Therefore, assuming the cancer risks were cumulative, the lifetime cancer risk for personnel inside the tanks at impact would increase from 23% to 23.07%. This is for the worst case example of two DU munitions penetrating a DU armored tank creating maximum aerosolization of the DU penetrator. The quantity of DU aerosols generated by impact on non-heavy armor tanks and lightly armored Bradley Fighting Vehicles would be less. Therefore, the increased lifetime cancer risk of 1 chance in 1,427 would also be worst case when compared to the actual exposures in the friendly fire incidents encountered in the Gulf War.

## 2) Chemical risk.

The chemical exposure for Level I individuals inside an Abrams M1A1 tank when two DU penetrators entered the crew compartment is conservatively estimated to be 52 mg intake of DU particles for a 15 minute exposure. The 52 mg intake contains about 9 mg of soluble DU based on test data indicating that up to about 17% of the airborne DU produced from impacts is soluble (ICRP Class D). For individuals who were in the vehicle when the DU penetrator did not enter the crew compartment, intakes of soluble DU are calculated to be much less, in the microgram range (14 µg).<sup>300</sup>

A comparison of the risks from radiation with the possible kidney effects of soluble uranium illustrates that heavy metal toxicity effects predominate over the radiological concerns.

## 3) Additional Comment

The risk estimates discussed above are for soldiers who could have inhaled soluble and insoluble DU produced when a heavy armor M1A1 is struck in its DU armor by two 120 mm DU penetrators. This scenario is believed to produce the highest exposure for a single event. That belief is based on the following considerations:

- There were no penetrations of the DU armor during any of the friendly fire incidents. Most of the damage to Abrams occurred by strikes in the rear of the vehicle which did not penetrate the crew compartment;

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<sup>299</sup> Memorandum for the Office of the Special Assistant Secretary for Gulf War Illnesses, Subject: Program Summary, USACHPPM Assistance with OSAGWI's Depleted Uranium (DU) Environmental Exposure Report, August 3, 1998.

<sup>300</sup> Memorandum for the Office of the Special Assistant Secretary for Gulf War Illnesses, Subject: Program Summary, USACHPPM Assistance with OSAGWI's Depleted Uranium (DU) Environmental Exposure Report, August 3, 1998.

- Impacts on Bradleys are believed to produce far smaller concentrations of airborne DU because their armor is much thinner than that of the Abrams, and is constructed of an aluminum composite;
- Data on airborne concentrations produced by DU penetrations of Bradley vehicles to include particle size distribution, elemental composition, and solubility of DU residues in simulated lung fluid;
- Refined assessments of the resuspension of DU residues inside and outside Abrams and Bradley vehicles to include particle size distribution, elemental composition, surface contamination levels (internal and external to the vehicle) and solubility of DU residues in simulated lung fluid;
- Adherence of airborne DU particulate materials to oily surfaces; and
- Adherence of airborne DU particulate materials to inorganic and organic compounds produced from target penetration and combustion.

Additional work is required to refine the following parameters as well as others that may be identified as the analysis proceeds:

- Data on airborne concentrations and particle size distribution of DU inside and outside armored vehicles;
- Data on airborne concentrations produced by DU penetrations of Bradley vehicles;
- Refined assessments of the resuspension of DU residues inside and outside Abrams and Bradley vehicles;
- Assessment of the Abrams NBC system and fire suppression system on the airborne DU concentrations;
- Additional data and refined assessments of the transfer of contamination by hands to the mouth, and from contaminated surfaces to wounds;
- Assessment of the Bradley's fire suppression system on the characteristics of DU airborne concentrations to include particle size distribution, elemental composition, and solubility of DU residues in simulated lung fluid;
- Assessment of the Abrams EC/NBC (Environmental Control/Nuclear Biological and Chemical) system and fire suppression system on the characteristics of DU airborne concentrations to include particle size distribution, elemental composition, and solubility of DU residues in simulated lung fluid.

## ***Tab O - Guidance for Protecting Troops***

The test and evaluation programs that paved the way for the fielding of DU munitions and armor acknowledged their potential for creating battlefield DU contamination. The Department of Defense (DoD) and the Services recognized the need to protect troops who might have to operate in such environments. Unfortunately, most of the guidance issued before and during the war was oriented toward peacetime accidents on US military installations, rather than addressing the very different demands of wartime/contingency operations. A number of memorandums and advisories containing simple, field expedient precautions and advice were sent to the theater, but often failed to reach units and troops who had to respond to accidents and events involving DU contamination.

The storage, handling and distribution of DU munitions and armor are governed by stringent guidelines based on Nuclear Regulatory Commission (NRC) licensing requirements. The Army used this guidance as the basis for developing procedures to respond to accidents such as tank fires or ammunition explosions where DU could be released into the environment. As such, the regulatory guidance was extremely restrictive, and in some respects poorly suited for operational deployments. Unfortunately, alternative guidance addressing battlefield requirements, and offering effective, field-expedient protective measures, was not widely disseminated during Operations Desert Shield/Desert Storm. Instead, the available, peacetime guidance was applied. The primary source of this guidance was TB 9-1300-278, which, as will be explained, mandated procedures that in a wartime context were often disproportionate to the actual hazard, or impractical.

### **1. Technical Bulletin 9-1300-278**

Technical Bulletin (TB) 9-1300-278, *Guidelines for Safe Response to Handling, Storage, and Transportation Accidents Involving Army Tank Munitions or Armor Which Contain Depleted Uranium*, was the Army's operative guidance for responding to incidents resulting in the localized release of DU. Dated November 20, 1987, it was revised in September 1990—in time for the Gulf War—and again in July 1996.

TB 9-1300-278 outlines procedures for responding to, and controlling the hazards resulting from, accidents and incidents involving DU. In addition to addressing the radiological and chemical toxicity hazard and contamination control, the guidelines also cover explosive and fire hazards, which are usually present as well. The TB was written to satisfy NRC licensing requirements. The NRC's requirements relate to protection of workers and the public from radiation during peacetime operations. Contamination levels are derived from "NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material." These guidelines set limits for returning formerly contaminated facilities (buildings, shops, etc.) to unrestricted use

by members of the public. Similar limits have been adopted by the Department of Energy, in its Radiological Control Manual,<sup>301</sup> and by other agencies

The Technical Bulletin instructs crews, explosive ordnance disposal (EOD), and radiation protection and firefighter personnel on how to deal with tank fires involving DU munitions and armor in peacetime. The guidelines are intended to provide maximum safety while protecting life and property. Examples of the guidelines (with OSAGWI comments in italics) include:

- Personnel should remain upwind, if possible, and a safety perimeter of at least 1,200 feet should be established and maintained around the involved vehicles and munitions to control access. *These are standard initial actions for any incident involving explosion hazards, regardless of whether or not DU is involved.*
- The ground around the tank should be surveyed and decontaminated as needed. Any openings in the tank (hatches or penetrations) should be sealed to prevent the spread of DU contaminants inside the hull. No attempt should be made to decontaminate the interior of the tank at the site of the accident. After the tank is removed, the surface underneath it should be surveyed and decontaminated. *These guidelines are intended to control and contain the contamination with minimal exposure and to make sure surrounding surfaces are returned to their pre-accident state as a matter of prudence.*
- Only EOD personnel should enter the tank to ensure that no explosive hazard is present. *EOD personnel are the only ones qualified to handle explosive hazards, e.g. rounds remaining from on-board ammunition stores.*
- EOD should be dressed in protective coveralls, gloves, rubberized boots and protective mask (i.e. Mission Oriented Protective Posture [MOPP] Level 4), with all exposed openings taped. *EOD troops, like all US troops in the Gulf Theater, deployed with MOPP 4 gear, making it the logical choice for personal protection. EOD troops, who were trained to operate in a DU-contaminated environment, generally chose not to follow these guidelines.*

These and other AMCCOM guidelines serve several purposes:

- Satisfy NRC license requirements.
- Protect the public from radiological exposure in keeping with ALARA.
- Make sure any incident is properly assessed, controlled, and cleaned up
- Protection of soldiers from radiological exposure in keeping with ALARA.

Many personnel whose missions required them to operate around DU-contamination, including at least one in-Theater Health Physicist with an active radiation control role, were not aware of the specific contents of TB 9-1300-278, or even of its existence.<sup>302</sup> In addition, a 1993 General Accounting Office (GAO) report found that TB 9-1300-278 was not widely available in

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<sup>301</sup> Radiological Control Manual, Department of Energy, DOE/EH-0256T Revision 1, US Department of Energy, Washington, DC, April 1994, p.2-12.

<sup>302</sup> Lead Sheet # 15854, Interview of former Army Health Physicist, April 6, 1998, p. 2.

late 1990 or 1991.<sup>303</sup> However, according to a former US Army major serving with the US Army Armament, Munitions, and Chemical Command (AMCCOM) at King Khalid Military City (KKMC) the manual was available at the time of the December 1990, tank fire in Saudi Arabia.<sup>304</sup> In any event, the guidelines contained in TB 9-1300-278 were largely unknown outside a few specialized teams (RADCON responders, Battle Damage Assessment Teams) deployed to the Gulf.

The DoD has acknowledged that pre-war DU awareness training was inadequate. Abrams crewmen received a brief block of training on the peacetime, regulatory requirements for handling DU munitions. More extensive training was provided to Nuclear-Biological-Chemical (NBC) response personnel assigned to most units, as well as EOD, RADCON, and safety personnel.<sup>305</sup> In general, this information was not shared outside these units or agencies. The lack of DU awareness was identified as a deficiency, as evidenced by a May 24, 1991, Memorandum from AMCCOM to TRADOC (Training and Doctrine Command) recommending that DU safety training be given to all armor and infantry soldiers and officers who required it.<sup>306</sup>

## 2. Other Warnings and Advisories

Before, during, and after the ground campaign, AMCCOM and other agencies issued warnings and advisories regarding specific measures to minimize exposures to DU. Too often, this information failed to reach commanders, officers, NCOs, and soldiers at the unit level. Many veterans have reported that they were completely unaware of DU, its properties, and safeguards and precautions to take against DU exposure.

Examples of supplemental guidance issued in support of the Gulf deployment include:

- A February 1991 message to Army Central Command (ARCENT) described proper procedures for the segregation and safe handling of tanks posing a radiological hazard after their DU armor or munitions were involved in a fire. These precautions were primarily designed to satisfy stringent NRC requirements for handling and disposal of DU-contaminated materials by civilian workers and facilities in a peacetime environment. Each unit was responsible for segregating equipment presenting a radiological risk. Contaminated equipment was to be inspected, encapsulated, and tagged prior to shipment back to the US to satisfy the requirements of peacetime radioactive material control. Access

<sup>303</sup> Operation Desert Storm - Army Not Adequately Prepared to Deal With Depleted Uranium Contamination, GAO/NSIAD-93-90. Washington, DC: United States General Accounting Office, Report to the Chairman, Subcommittee on Regulation, Business Opportunities, and Energy, Committee on Small Business, House of Representatives, January 1993, p. 35.

<sup>304</sup> Lead Sheet # 5680, Interview of US Army Major who was AMCCOM Operations Officer at KKMC during the Gulf War, August 1, 1997.

<sup>305</sup> Operation Desert Storm - Army Not Adequately Prepared to Deal With Depleted Uranium Contamination, GAO/NSIAD-93-90. Washington, DC: United States General Accounting Office, Report to the Chairman, Subcommittee on Regulation, Business Opportunities, and Energy, Committee on Small Business, House of Representatives, January 1993, p. 34.

<sup>306</sup> Memorandum from AMCCOM to TRADOC, Subject: Depleted Uranium (DU) Contamination, May 24, 1991.

to the contaminated equipment was to be limited to contain the spread of contamination beyond the damaged tank.<sup>307</sup>

- A March 3, 1991 memorandum to theater recommended that clothing and gloves worn inside contaminated systems be left inside the system upon exiting, and that hands be washed. It also advised against eating or smoking inside a contaminated system to decrease the probability of ingesting DU.<sup>308</sup> Later that month, a message was sent to the Gulf advising that "any system struck by a DU penetrator can be assumed to be contaminated with DU."<sup>309</sup>
- As late as April 7, 1991, the AMCCOM team at KKMC requested advice from its higher headquarters on examination and monitoring requirements for crewmembers of vehicles hit by DU penetrators.<sup>310</sup> This advice came in the form of an April 11, 1991, memorandum, which states that the local Radiation Protection Officer (RPO) or medical authority has the responsibility to determine if, and when, a medical exam or bioassay is required. This same memorandum states that "in the event that a vehicle is hit by a DU penetrator the likelihood that a crew member would receive an excessive dose of radiation is minimal." It goes on to say that, in the case of a tank fire or DU penetration, the crews would be expected to have abandoned the vehicles before receiving an excessive dose.<sup>311</sup>

These messages were aimed at ensuring adherence to the ALARA principle to minimize potential exposures. Some guidance given to selected groups was less restrictive. The Battle Damage Assessment Team (BDAT), tasked with evaluating destroyed US combat vehicles, were instructed to wear anti-contamination suits (cotton overgarments) and dust masks.<sup>312</sup> This protective posture was the same as that used by range personnel at Aberdeen Test Center, where several of the BDAT members worked prior to the war. This locally developed guidance applies to range workers who work with hard target impact testing, and has been validated by years of medical surveillance on the range workers, to include annual lung scans.<sup>313</sup>

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<sup>307</sup> Message from CDRTACOM in Warren, MI. to J4, ARCENT HQ, Subject: "Field Processing of Tanks Contaminated With Depleted Uranium (DU)," February 1991.

<sup>308</sup> Memorandum from AMCCOM (Army Munitions and Chemical Command), Subject: Tanks and Armored Vehicles Contaminated With Depleted Uranium (DU), March 3, 1991.

<sup>309</sup> Message to Headquarters ARCENT, Subject: Depleted Uranium (DU) Contamination, March 7, 1991.

<sup>310</sup> Memorandum for AMCCOM, Subject: Recommend That Safety Have Lead with Support by the Command Surgeon, April 7, 1991.

<sup>311</sup> Memorandum to AMCCOM-SCR/SWA, Subject: Concept Plan for Disposal of Depleted Uranium (DU) Contaminated Vehicle in Southwest Asia (SWA), April 11, 1991.

<sup>312</sup> Lead Sheet #15330, Interview of a Major in the Battle Damage Assessment Team, March 5, 1998, p. 2.

<sup>313</sup> Lead Sheet #16157, Interview of the Chief of the Safety Division, Army Test and Evaluation Command, April 22, 1998.

### **3. Apparent Contradictions between Guidance and Wartime Practices.**

A comparison of the guidelines outlined in TB 9-1300-278 and actual practices followed during the Gulf War invites criticisms that the Services disregarded regulatory guidance put in place to protect human health and ensure the proper handling of battlefield contamination. While the perception is understandable, the reality is more complex.

Shortcomings in pre-war training and awareness of DU were not effectively remedied by supplemental guidance—mainly warning messages and advisories—that in many cases did not reach tactical units. At the same time, a review of the operative guidance in force at the time of the Gulf War indicates that much of this guidance was in fact excessive and impractical in an operational setting. In particular, the emphasis on donning the MOPP 4 chemical warfare ensemble before working in or near DU-contaminated equipment deserves examination.

MOPP 4 is explicitly associated in most soldiers' minds with protection from Nuclear- Biological-Chemical hazards. "Nuclear" in this sense means fall-out from tactical nuclear detonations, which produce high-order concentrations of primarily gamma radiation, as opposed to DU, which produces mainly alpha particles which are too weak to penetrate the outer layer of skin.

Biological and chemical agents can take the form of gases, vapors, or liquids, necessitating the features found in MOPP 4 gear, i.e.: gas mask with protective hood, charcoal-filled overgarments, and rubber "booties" and gloves. DU, on the other hand, poses a credible hazard only when its oxides, residues, or fragments are internalized in the body via inhalation, ingestion, imbedding, or wound contamination, in sufficient quantity.

Exposure hazards, no matter how slight, require suitable protection under ALARA. The level of protection afforded by MOPP 4 was excessive, in the view of many experts. However, it was mandated largely because every soldier deployed to the Gulf had MOPP 4 gear and knew how to use it. Hence it was a viable, field-expedient means by which to prevent exposures. In addition, suitable alternatives such as dust masks were often unavailable through normal supply channels.

Another potential inconsistency was the precautions taken by the Radiation Control (RADCON) personnel deployed to the Gulf. Unlike ordinary troops, these personnel were specifically trained and equipped to respond to DU contamination. However, they often elected to work on contaminated systems without such TB 9-1300-278-recommended protection as respirators or dust masks. The reason for this is simple: In their professional judgement, the radiological and chemical toxicity hazard was too low, in these instances, to warrant the wear of respirators or dust masks. This subjective judgement may seem at odds with existing guidance, but the reader should be reminded that guidance is just that—and the RADCON experts felt that they had the experience and expertise to determine the appropriate level of protection.

In short, the operative guidance available at the time of the Gulf War, based on peacetime regulatory requirements, set protection levels that proved to be disproportionate to the actual

hazard. Unfortunately, formal guidance that would have satisfied regulatory requirements while more definitively addressing actual requirements had not been developed. Although supplemental guidance was developed and sent to the theater, it was not widely disseminated outside the very small community (mainly RADCON experts) with a specific DU-related mission. Among tactical units, awareness of DU's characteristics and its potential hazard remained very low, in general. In consequence, many personnel were needlessly exposed to DU during clean up and recovery actions, or other activities.

The deficiencies in Gulf War guidance have been recognized by the Army, which has taken steps to remedy the situation. A meeting was conducted in April 1998 to discuss organizational roles and responsibilities relative to low level radioactive hazards in operational settings. An Integration Process Team (IPT) was formed to review low-level radiation as well as nuclear, biological, and chemical hazards, and associated environmental issues. At the soldier level, the Army has developed a new common training task "Respond to Depleted Uranium /Low-Level Radioactive Materials (DULLRAM) Hazards".

The DULLRAM training task, due to commence in FY99, should produce a dramatic, sustained improvement in troop awareness of DU. It addresses two primary concerns associated with earlier guidance: 1) It protects health while recognizing the utility of field-expedient protective measures, and 2) While Gulf War-era guidance was not widely available or circulated outside of the small, specialized units with a radiation control or health physics role, the DULLRAM lesson plan will be universal. Every soldier will receive this training during their initial Army training, with refresher or periodic training held over the course of their military service.

Regarding the first point, the training task offers practical, field-expedient measures to protect soldiers from exposures without imposing excessive personal protection requirements. In contrast to earlier guidance, it advises soldiers to only use protective masks if working in an area where there is heavy smoke from burning vehicles or the dust plume from the impact has not settled.

The DULLRAM is a simple, uniform, and effective lesson plan that explains:

- Identified possible hazards (conditions under which DU contamination might be encountered)
- Assumed field expedient respiratory protection (cravat/handkerchief) or donning a protective mask (gas mask) as appropriate
- Warning others of the DU hazard
- Protection from contact with DU
- Reporting suspected DU contamination to supervisors/superiors.<sup>314</sup>

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<sup>314</sup> US Army Common Task 031-503-1017, "Respond to Depleted Uranium/Low Level Radioactive Materials (DULLRAM) Hazards", July 1998.



The DULLRAM task lesson plan and training requirement will impress on ordinary soldiers, as well as supervisors and leaders, the importance of recognizing DU contamination as a battlefield hazard, and responding appropriately.

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**Office of the Special Assistant  
to the Deputy Secretary of Defense  
for Gulf War Illnesses**



**ANNUAL REPORT**

**November 1996 - November 1997**

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### Note to Readers:

This is the second printing of the Annual Report  
Minor grammatical and format corrections have been incorporated.

## INTRODUCTION

We recently marked the one year anniversary of the establishment of the Office of the Special Assistant for Gulf War Illnesses, and it is appropriate to review our efforts during the past year and to report on our plans for the future.

At the start of the year many at the Defense Department asked, "How did we get into this mess?" The best answer that we can give is that the DoD finds it very hard to deal with battlefield casualties that don't manifest themselves in traditional ways. The loss of public credibility over Gulf War illnesses follows similar problems with Agent Orange and POW/MIAs after the Vietnam War. In this case, as the crisis over Gulf War illnesses grew, we did not listen to the veterans nor did we provide them with the information they needed to alleviate their fears and answer *their* questions. Today, much has changed in the way the Defense Department relates to those who served in the Gulf.

We are working very hard to answer the question most frequently asked—"Why are so many veterans sick?" Despite a substantial increase in funds allocated to medical research, we still do not have answers to that basic question. While a careful review of past medical studies, now underway, may yet provide some new insights, recently funded research is not likely to provide answers either quickly or easily.

Even though the causes of unexplained Gulf War illnesses remain elusive, the men and women who served in the Gulf also want and deserve to know if they were exposed to anything that could threaten their health. This question is the unique responsibility of the Department of Defense. We owe it both to the veterans of the Gulf War and to those who serve today to ensure that we learn from the experiences of the war in order to better protect those who will serve in the future.

The following report reviews the events leading up to, and the establishment of, the Office of the Special Assistant for Gulf War Illnesses. We highlight four significant changes put in place over this past year and review the more important results of our investigations into possible exposures from chemical or biological agents. We also highlight significant activities with other agencies as examples of the depth of our investigations. Finally, we review what lessons we have already learned and how this work will continue next year.

Put into perspective, our efforts are part of a much broader program by the Administration that has involved a number of offices in the Department of Defense (DoD) and across the Government. We are all committed to President Clinton's pledge to "leave no stone unturned" in our efforts to care for those who fought in the Gulf War.

## THE FIRST YEAR IN BRIEF

The following is a partial list of what we have accomplished during the first year of operations of the Office of the Special Assistant. Most important are the lessons we have learned for the future, and our efforts to change the way the Defense Department does business.

## **Accomplishments**

Major changes were initiated with the establishment of the Office of the Special Assistant:

- We are listening to our veterans and incorporating what they tell us into our investigations. We received almost twelve hundred postal letters and twenty seven hundred e-mail letters through the Internet. Our "veteran contact managers" spoke with almost twenty nine hundred veterans by phone.
- We have developed an outreach program including GulfLINK and GulfNEWS, and met with veterans at thirteen "Town Hall" meetings and four national veterans conventions throughout the United States. We also frequently meet with Veterans Service Organizations and Military Service Organizations to discuss topics of interest to them.
- We are systematically investigating and reporting on possible chemical and biological agent exposures. This includes substantial field testing to determine the likely level of exposure resulting from the detonations of sarin filled rockets at Khamisiyah. We have published four information papers and nine case narratives.
- We have extended our inquiries to "other causes" for Gulf War illnesses, such as the fumes from oil well fires, depleted uranium and pesticides.

## **Lessons Learned**

For our efforts to be meaningful, we have to learn from our experiences. Gulf War illnesses, as before it Agent Orange and POW/MIA, represent nontraditional issues that the Department of Defense must deal with in a more effective manner. Specifically, our efforts are helping the Department understand how to build and maintain trust and confidence in the DoD by the American people. Specific to Gulf War illnesses, we need to better account for what happened on the battlefield, and in the future, to better protect our troops on the battlefield from nontraditional risks. Here are some of the things we have learned and are doing:

- To build and maintain trust and confidence in the Department, we are institutionalizing our veteran outreach programs to maintain communications with concerned individuals and their organizations.
- To better account for what happened on the battlefield, we are developing better time and location data and new programs for retaining, safeguarding and archiving important records, including individual health records.
- To protect our troops on the battlefield, we are building better detectors and alarms. We need to initiate better training concerning the inevitability that sensors designed for the maximum protection of our troops will also be prone to false alarm.



- Force medical protection has become a significant program of the JCS and OSD Health Affairs. It will be fully implemented and expanded to cover emerging environmental risks.
- We will fully implement our programs concerning how to handle hazardous material, including how to handle vehicles struck and contaminated by depleted uranium rounds.

The establishment of the Office of the Special Assistant for Gulf War Illnesses was a significant commitment by the Defense Department. While we have made progress during our first year, more has to be done. If our first year is any guide, our programmed work will change as new information is gained from our various studies and investigations. Working with the new President's Special Oversight Board, to be chaired by former Senator Warren G. Rudman, we hope to complete our inquiries into possible chemical and biological exposures and a number of significant environmental hazards, and can start to draw down the Office. The Department must continue, however, to work with our veterans and their organizations to ensure that we answer their questions and provide them with all the information they need concerning what happened in the Gulf and how it might have affected their health.

#### **EVENTS LEADING UP TO THE ESTABLISHMENT OF THE OFFICE OF THE SPECIAL ASSISTANT**

Soon after the Gulf War some American veterans, and later a handful from other nations, reported a variety of illnesses and disabilities. One issue raised early in the search for a cause was the possible exposure to chemical or biological agents. In testimony before the Congress, and in press interviews, senior Defense officials asserted that Iraq did not use offensive chemical weapons. To many observers, however, these statements were difficult to reconcile with a number of first hand reports by chemical detection teams, both US and foreign, that chemical agents were present on the battlefield. In the eyes of many in Congress, the media, and many Americans, the DoD was not telling the truth.

In retrospect, the Department was given sage advice by a junior Marine Corps officer in a prophetic recommendation made in an official Marine Corps report on "Marine Corps NBC Defense in Southwest Asia." In the report, then-Captain David Manley noted that:

Survey data indicates that a significant number of Marines believe they encountered threat chemical munitions or agents.... There are no indications that the Iraqis tactically employed agents against Marines. However, there are too many stated encounters to *categorically dismiss* the presence of agents and chemical agent munitions in the Marine Corps sector (emphasis added).

In 1995, given the inability to come up with answers concerning the causes of the illnesses and the inconsistencies between the statements of senior Defense officials and those who served in the Gulf, President Clinton took decisive action. He established the

Presidential Advisory Committee on Gulf War Veterans' Illnesses (PAC) and ordered the various departments of the Federal Government to reexamine the issues of possible exposure to chemical or biological agents during the Gulf War. The DoD and the CIA initiated new reviews of operational, intelligence and medical records. In March 1995, then-Deputy Secretary of Defense, Dr. John Deutch, established a Senior Oversight Panel, and created the Persian Gulf Illnesses Investigation Team (PGIIT) within the Office of the Assistant Secretary of Defense for Health Affairs.

In September 1995, a reassessment of information by the CIA indicated Khamisiyah as a possible chemical agent release site. With this new information, the PGIIT was able to determine which troops had been at Khamisiyah. A May 1996 UNSCOM inspection of Khamisiyah documented that 122 mm chemical rockets were in Bunker 73. In June 1996, the DoD announced that it was likely that American troops had unknowingly destroyed sarin-filled 122 mm rockets in March of 1991 at Khamisiyah.

In September 1996, the new Deputy Secretary of Defense, Dr. John White, referred to Khamisiyah as a "watershed," and asked Dr. Bernard D. Rostker, Assistant Secretary of the Navy (Manpower and Reserve Affairs), to put together a team to look at everything the Department was doing concerning Gulf War illnesses. We examined all aspects of DoD's program and concluded that DoD's then current effort was overwhelmed by Khamisiyah. An example of this was that while the PGIIT had established an 800 hot line to give those who served in the Gulf an opportunity to tell their story, they were unable to follow-up these initial phone reports. By September 1996, they had a backlog of more than twelve-hundred phone reports. It was clear to us that we needed a broader focus, an expanded effort, and a strategy for systematically examining the various theories concerning the nature and cause of Gulf War illnesses. We also needed a plan to effectively communicate DoD's findings to our veterans and the American people.

On November 12, 1996, Dr. White directed the establishment of the Office of the Special Assistant for Gulf War Illnesses with broad authority to coordinate all aspects of the Department's programs. Dr. White concluded that the Department had not placed sufficient emphasis on the operational aspects of the war and the implications of those operations. He asked that we put a special focus on the operational issues and issues of future force protection of our troops. He emphasized the need to ensure that we had a communication program to reach out to the veterans and to try to learn from them what went on during the war. Responsibility for health related programs, specifically the clinical program and the health research program, remained with the Office of the Assistant Secretary for Health Affairs.

## **ESTABLISHING THE OFFICE OF THE SPECIAL ASSISTANT**

The Office of the Special Assistant was designed around a three part "Mission Statement" (Figure 1) which emphasized our commitment to our service personnel and veterans who served in the Gulf, and focused on operational impacts on health and future force protection.

## **Mission of the Office of the Special Assistant for Gulf War Illnesses**

### **To Ensure That**

- **Veterans of the Gulf War are appropriately cared for**
- **DoD is doing everything possible to understand and explain Gulf War Illnesses**
- **DoD puts into place all required military doctrine, and personnel and medical policies and procedures to minimize any future problem from exposure to biological and chemical agents and other environmental hazards**

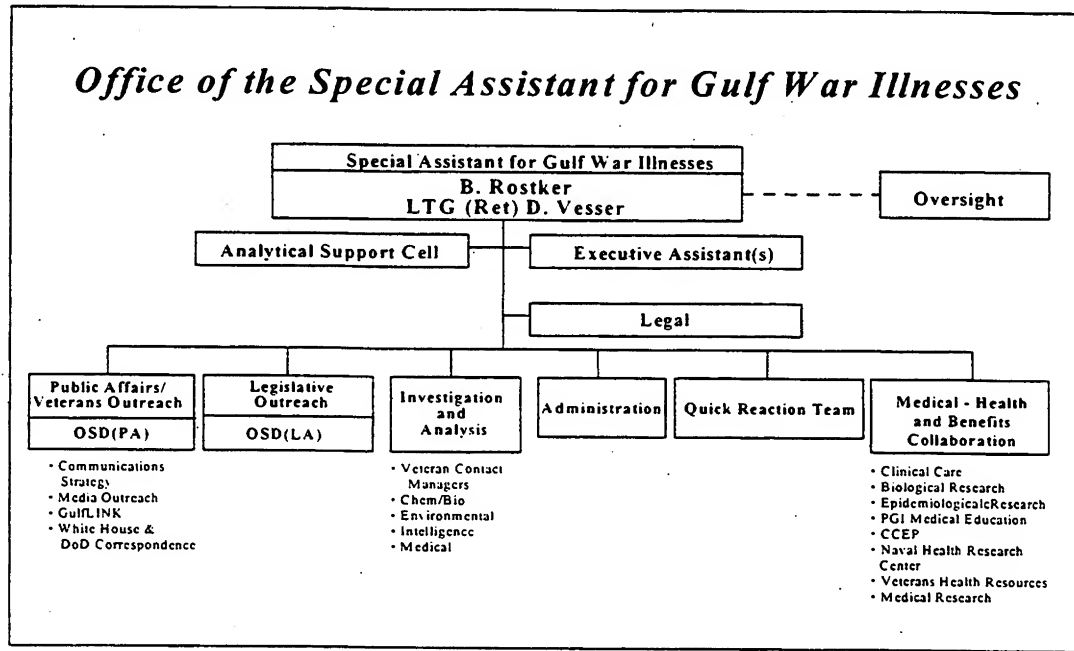
**Figure 1**

The Assistant Secretary of Defense for Health Affairs continued the specific responsibility to care for our service men and women still on active duty, while the Department of Veterans Affairs is the primary health care provider for those who have left the service. We included, however, "care of those who served in the Gulf" in our mission statement to remind us that the health of our people *must* come first. With this focus, we worked with the Assistant Secretary of Defense for Reserve Affairs to make sure that reservists received the full health care and compensation benefits they were entitled, and where current legislation and rules were inadequate, to work towards changing the law and directives.

Our mission charges us to do everything possible to understand and explain Gulf War illnesses, to inform the Gulf War veterans and the American public of our progress, and then to ensure that DoD makes whatever changes are required in equipment, policy and procedures. This is not limited to just the possibility of chemical and/or biological agent exposure, but includes a broader inquiry into such possible causes of illnesses as adverse reactions to vaccinations and/or pyridostigmine bromide (PB), as well as such potential health threats as pesticides, depleted uranium (DU), oil well fires, and even fine sand.

With our mission statement to guide us, we needed to quickly increase DoD's effort. We selected a number of contractors who provided the flexibility, expertise, and support needed to create the new organization. We should note that outstanding assistance was provided by OSD Administration, the DoD Comptroller and the General

Counsel. We borrowed people from OSD Legislative Affairs and OSD Public Affairs, the National Imaging and Mapping Agency (NIMA), and the Services. When we finished, our team was a mix of DoD civilians, active duty military, and contractor personnel, many of whom were veterans themselves. Figure 2 is the organization chart for the new office



**Figure 2**

The new organization incorporated a Public Affairs section to coordinate outreach to the veterans' community and to develop and implement our communications strategy; a Legislative Affairs section to coordinate all testimony and focus our relations with Congress; and, a Legal Office to provide legal advice on FOIA, Privacy Act, copyright and other legal issues. A Quick Reaction team was established to respond to high priority issues such as the Dugway demolition tests that will be discussed later. An Administrative Section was established to manage GulfLINK and the many documents we must handle, as well as the challenge of responding to all correspondence sent to DoD and the White House on Gulf War illnesses. Table 1 provides selected statistics for the past year that highlight the diverse and sizable administrative tasks the new office has completed.

The Medical - Health and Benefits Collaboration office works with the Office of the Assistant Secretary of Defense for Health Affairs and other health related organizations such as Veterans Affairs, Health and Human Services, and the Persian Gulf Veterans' Coordinating Board. We provided a viewpoint different from the traditional medical community, and, along with OASD(HA), have been able to ensure that research proposals that are important to the Government's overall strategy of answering the concerns of Gulf War veterans were fully addressed and funded.

Select Administrative Statistics As of November 1997			
Category	Work Completed	Pending	Total
<b>Correspondence</b>			
DoD congressional	156	8	164
White House	223	13	236
OSD	54	8	62
OSAGWI	683	129	812
FOIA	17	6	23
<b>TOTAL:</b>	<b>1,133</b>	<b>164</b>	<b>1297</b>
<b>Hotline</b>			
Incoming (New Calls)	1,872		
Call-backs (New Calls)	1,613	259	1,872
Call-backs (Backlog)	1,054	142	1,196
Contacts for Investigations	1,252	1,572	2,824
<b>E-Mails</b>			
	2,521	122	2,643
<b>Document Holdings</b>			
Inventoried/controlled	11,033	18,967	30,000
Scanned*	908	29,092	
<b>Oversight Support</b>			
	3,722 hrs.		
(Presidential Advisory Committee, Senate Veterans Affairs Committee, Government Accounting Office, etc.)			
*Scanning/Archiving effort began September 1997.			

**Table 1**

The core of our effort is the Investigation and Analysis Directorate (IAD), which investigates events surrounding possible causes of illnesses and publishes results as case narratives and information papers. This division is also responsible for our 800 hotline and our phone outreach program.

## A NEW WAY OF DOING BUSINESS

In building the Office of the Special Assistant for Gulf War Illnesses, we needed to make some major changes from the earlier efforts. First, we had to do a better job of listening to our veterans' concerns and problems, and incorporating what they were telling us into our investigations. Second, we needed to develop an outreach program in order to effectively communicate with our veterans. Third, we needed to significantly expand the formal investigation process for researching possible chemical and biological agent exposures. And fourth, we needed to expand our investigations beyond chemical and biological agents to include other potential causes of Gulf War illnesses.

### First Change: Listening to our Veterans

Our first change was to *listen* to our Gulf War veterans—the people who were actually in the Gulf and who are in the best position to shed light on the events of the war. We created the Veterans Data Management Division in the Investigation and Analysis Directorate (IAD), staffed by trained “Contact Managers” (CMs), all of whom are veterans and all of whom work directly with the individual Gulf War veterans. Today,

within 48 hours of their initial report to our 800 hotline, veterans are fully debriefed by a CM. The CM becomes the primary point of contact between the veteran and our office. Since this is often the first time the veteran has spoken to anyone from DoD about their experiences in the Gulf, the phone conversations often take several hours. We try to answer the questions that the veterans have long wanted answered and to provide information about on-going efforts, including referral information for those needing support from DoD or the VA.

The CMs are the eyes and ears of our investigators, and ensure that the veterans' full accounts are folded into the analysis. They have interviewed veterans who called the hotline, or responded to surveys and indicated that they may have information needed in our studies, or who contacted our office through letters and e-mail. The CMs have attempted to reach all those twelve hundred veterans whose initial calls to PGIIT had been unanswered; they have been successful in all but one-hundred forty-two cases, where they have not been able to develop a valid phone number. All in all, our contact managers have talked to almost thirty-nine hundred veterans during the last year.

### **Second Change: Developing an Outreach Program**

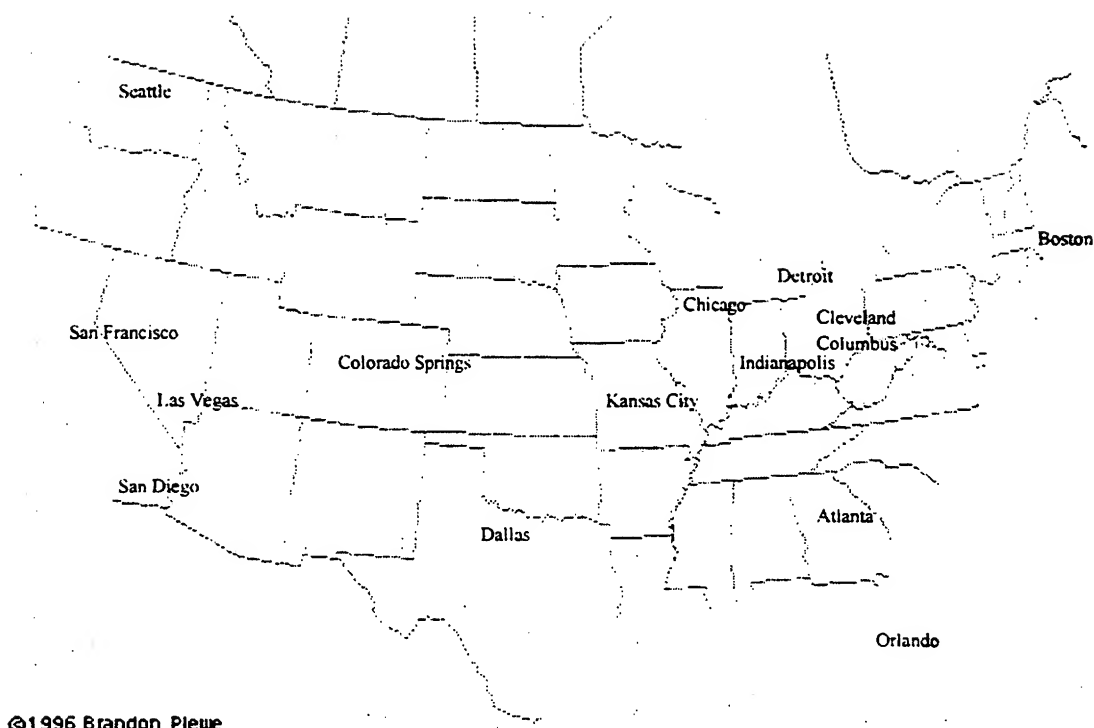
We immediately established an "open door" policy with the media, veterans groups, Congressional staffs, and the PAC. We began holding regular meetings with Veterans Service Organizations (VSOs)/Military Service Organizations (MSOs) to address their questions and concerns. We have hosted VSO/MSO meetings on such topics as chemical alarms and reconnaissance vehicles, depleted uranium, and medical record keeping.

Starting in March 1997, and working with the Veterans of Foreign Wars and the American Legion, we began a series of "Town Hall" meetings to update the veterans on our progress and to hear first hand of their concerns. To date, we have visited fifteen cities (thirteen town hall meetings and four national conventions) as shown in Figure 3.

GulfLINK has been a great success. Typically, we get over sixty thousand home page "hits" in any given week, and we peak at over ninety thousand hits per week during important times such as when we announced the results of our analysis of fallout from the explosions at Khamisiyah. We are very proud that GulfLINK was recently awarded the Government Computer News Agency Award for excellence in the application of information technology to improve services delivery.

We recognize that many veterans do not have Internet access and, to reach them, we developed a bi-monthly newsletter, *GulfNEWS*, with a current circulation of more than seven thousand and growing.

We also realize that veterans want to know about our investigations as they pertain to their own Gulf War experiences. Therefore, in addition to publicizing our findings in the case narratives, we write to each affected veteran, providing a synopsis of our findings. To date, we have sent more than 150 thousand letters to Gulf War veterans concerning possible exposure to chemical agents. In the case of Khamisiyah, we have told those receiving letters that they may have been briefly exposed to low levels of sarin. In all other cases, however, we have been able to tell veterans that it was unlikely they were exposed, or that they were definitely not exposed.



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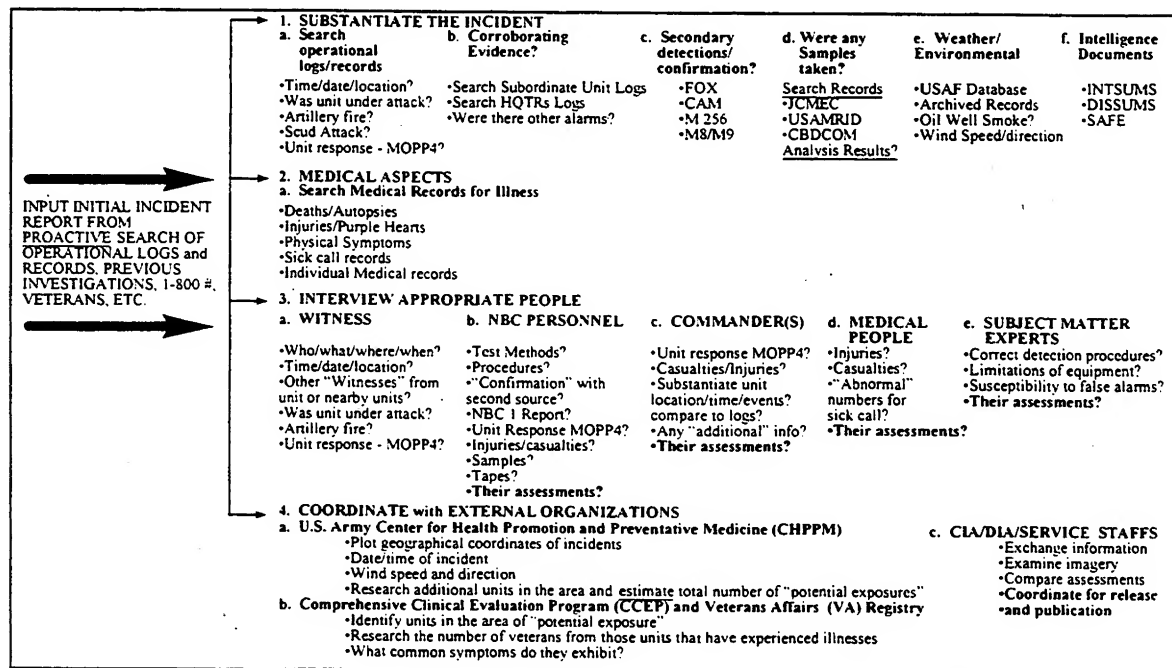
Figure 3

### Third Change: Investigating and Reporting on Possible Chemical and Biological Agent Exposures

We expanded and intensified our efforts to investigate incidents, and to report them to the American people. The resulting “Case Narratives” report on our investigations into possible exposure of our troops to chemical and biological agents. Corollary “Information Papers” provide background material—such as the strengths and limitations of chemical alarms and detection equipment—which helps the reader to better understand the findings reported in the Case Narratives. We have published nine case narratives and four information papers.

We devised our methodology from chemical agent investigation and validation standards developed by the United Nations and the international community. A case always starts with a report of a possible chemical or biological exposure, usually from a veteran. As illustrated in Figure 4, we seek to identify *all* of the information that might be available about any particular incident. However, given the passage of time since the Gulf War, we have found it to be difficult to obtain certain types of documentary evidence, and we know that physical evidence was often not collected at the time. Therefore, we cannot apply a rigid template to all incidents, and each investigation is tailored to its unique circumstances.

Our investigations include information from first-hand witnesses who provide valuable insight into the conditions surrounding the incident and the mind-set of the personnel involved—particularly important where physical evidence is lacking. We interview NBC officers and personnel trained in chemical and biological testing, confirmation, and reporting to determine how the involved unit may have responded at the time, what tests were run, whether any known injuries were sustained, and what reports were submitted. We ask commanders for their perspective; what did they know, what decisions did they make, and what was their assessment of the incident. Where appropriate, subject matter experts also provide opinions on the capabilities, limitations, and operation of technical equipment, and submit their evaluations on selected topics of interest.



**Figure 4**

Case narratives contain the *facts* that we have been able to find concerning a suspected incident. In a separate section, we provide our *assessment* of these facts and make a judgment concerning the presence of chemical or biological agents. The sections are separated to make clear what is fact and what is opinion.

Even after intense investigation, information from various sources may be contradictory. Thus, we use a five part assessment scale that ranges from "Definitely" to "Definitely Not," with intermediate assessments of "Likely," "Indeterminate," and "Unlikely" to describe how our analysts appraise the information. While the assessment often gets the most attention, it is the least important part of the case narrative. The purpose of the case narrative is to get all the facts before the American people. We believe the credibility of our work lies with the quality and completeness of our investigations.



Since we recognize that we may not have all the facts, case narratives are interim reports. Figure 5 is a typical case narrative cover sheet. It highlights a 1-800 telephone number so that veterans can call and provide additional information that will enable us to report more accurately on the events being investigated. Final reports will be issued only when we are satisfied that we have exhausted all avenues in our search for information and can tell the complete story of a specific event or issue.

<h2 style="text-align: center;">Case Narrative</h2> <h3 style="text-align: center;">Fox Detections in an ASP/Orchard</h3> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"><p>Case Narratives are reports of what we know today about specific events that took place during the Gulf War of 1990 and 1991. This particular case narrative focuses on reports of possible chemical agent detections by a Fox vehicle attached to Task Force Ripper in an Ammunition Supply Point (ASP) in an Orchard southwest of Kuwait City. This is an interim report, not a final report. We hope that you will read this and contact us with any information that would help us better understand the events reported here. With your help, we will be able to report more accurately on the events surrounding these possible chemical agent detections. Please contact my office to report any new information by calling:</p><p style="text-align: center;"><b>1-800-472-6719</b></p><div style="text-align: right; margin-top: 20px;"><p>Bernard Rostker Special Assistant for Gulf War Illnesses Department of Defense</p></div></div>
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**Figure 5**

During the months ahead, we will continue to investigate and publish a number of additional case narratives and information papers relating to various reports of chemical and biological agent use, detection, and exposure. These investigations will cover, among other topics, reports of chemical injuries, suspected chemical agent storage sites, and reported detections of chemical agents. We are committed to looking into any incidents that may shed light on why our veterans are sick.

#### **Fourth Change: Extending the Inquiry to "Other Causes" for Gulf War Illnesses**

Much attention has been paid to the possible exposure of Gulf War veterans to chemical and biological agents. However, these are only two of many adverse exposures that could have impacted the health of those serving in the Gulf. Therefore, we have initiated a number of other studies into the various environmental factors and unique occupational risks to which our veterans may have been exposed.

The first "environmental" studies, now in progress, address the exposure of our troops to depleted uranium, oil well fires, and pesticides. These studies differ significantly from our work on specific chemical incidents. They are not designed to assess the likelihood that our troops were exposed to a specific agent at a specific place and time, but rather to a more general understanding of the hazards faced by our forces.

However, exposures are only half of the puzzle. To complement our examination of what happened during the Gulf War and to allow us to assess the possible health risk impacts of a number of factors, we need to better understand the state of medical science. RAND, a federally funded research and development center, was commissioned to prepare reviews of the existing scientific literature on eight of the possible causes of illnesses among Gulf War veterans. Each will be peer-reviewed by independent scientists who are distinguished in their fields, and each will be accompanied by a separate summary written specifically for the veterans. RAND is producing reviews on the following topics which are scheduled for release in early 1998:

- Chemical and biological warfare agents
- Immunizations
- Pesticides
- Pyridostigmine bromide
- Stress
- Infectious disease
- Fallout from oil well fires
- Depleted Uranium

We believe that these four changes, together with a substantial increase in DoD resources, gives us the ability to answer many questions veterans have asked. The next section highlights the case narratives and information papers that report what we have learned.

#### **CASE NARRATIVES AND INFORMATION PAPERS OF POSSIBLE CHEMICAL AND BIOLOGICAL AGENT EXPOSURES**

Since the publication of our first case narrative dealing with Khamisiyah last February, we have published four information papers and eight additional case narratives. (The full reports are available on GulfLINK.) The information papers published are:

- Mission Oriented Protective Posture (MOPP) and Chemical Protection, November 13, 1997
- M8A1 Automatic Chemical Agent Alarm, November 13, 1997
- Medical Surveillance During Operations Desert Shield and Desert Storm, November 13, 1997
- The Fox NBC Reconnaissance Vehicle, July 29, 1997.

Case Narratives published are:

- Tallil Air Base, Iraq, November 13, 1997
- Fox Detections in an ASP/Orchard, September 25, 1997
- Al Jaber Air Base, September 25, 1997
- Reported Mustard Agent Exposure Operation Desert Storm, August 28, 1997
- Al Jubayl, Saudi Arabia, August 13, 1997
- Possible Chemical Agent on SCUD Missile Sample, August 13, 1997
- US Marine Corps Minefield Breaching, July 29, 1997
- Camp Monterey, May 22, 1997
- Khamisiyah, February 21, 1997; republished April 14, 1997

These reports, published on GulfLINK, range in size from the 96 page Al Jubayl report—which covered three incidents in Al Jubayl, Saudi Arabia, in early 1991—to a 10 page analysis of possible chemical agents on a piece of SCUD missile. Each report cites numerous source documents, hyper-linked to footnotes in the case narratives.

Taken together, the case narratives and information papers *start* to provide a picture of what really happened to US and coalition troops during Operation Desert Shield and Operation Desert Storm, and the months after the war. The picture, however, is not complete and must be filled in by the additional case narratives that will be published in the months ahead.

The most significant case narratives, thus far, are the one about Khamisiyah, and the collection of case narratives concerning the possible presence of chemical agents in Kuwait.

## **Khamisiyah**

Our inquiry has focused on two questions: what happened at Khamisiyah and why did it take so long for the DoD and CIA to realize chemical munitions were destroyed there in early March 1991?, and who was exposed to what level of sarin as a result of detonating stacks of chemical-filled 122 mm rockets in the open pit at Khamisiyah?

**What Happened At Khamisiyah And Why Did It Take So Long For The DoD And CIA To Realize Chemical Munitions Were Destroyed There In Early March 1991?**

The story of Khamisiyah is told in two reports by the DoD and the CIA, and independently corroborated by the Army Inspector General's investigation. (All three reports have been posted on GulfLINK.) We have described Khamisiyah as an enigma: how could there have been a major chemical incident when, as the Army IG reported, "no chemical weapons were detected during the operation itself [and] units neither knew nor suspected that they were destroying chemical munitions." Without contemporaneous operational or medical reports, investigators were skeptical about initial UNSCOM and Iraqi accounts that US forces had destroyed chemical weapons at Khamisiyah. In addition, a review of the testimony and responses to questions by DoD in 1994 before the Senate Banking, Housing, and Urban Affairs Committee (the Riegle Committee) shows how confused DoD witnesses were about the location of Khamisiyah and its proximity to US troops. DoD analysts continued to believe that any destruction of chemical munitions probably had occurred after the war as part of an Iraqi deception campaign.

Credit for correctly putting the pieces of the puzzle together goes to the CIA. This is how it is explained in the CIA report (which is available on GulfLINK):

Because of the increased focus on Gulf war illness issues by both the public and Congress, as well as concerns raised by two CIA analysts, Acting Director of Central Intelligence Studeman authorized a comprehensive review of intelligence by CIA on the issues related to the Gulf war in March 1995. ... possibility that US forces could have been exposed to fallout from US bombing of Iraqi CW production and storage facilities. As part of this study, a CIA analyst constructed a comprehensive summary of Iraqi CW-related facilities, focusing on the status and disposition of CW agents at these sites. ... The Khamisiyah facility emerged as a key site that needed to be investigated because of its proximity to Coalition forces and the ambiguities surrounding the disposition of chemical weapons at the site. CIA informed DoD's Persian Gulf Investigative Team (PGIT) in September 1995 of Khamisiyah's importance and requested additional information about US troop activities there to which PGIT responded in October....

CIA and DoD personnel met with UNSCOM officials on 19 March 1996. ... UNSCOM indicated that it planned to revisit Khamisiyah to resolve newly raised munitions accounting issues.... At the 1 May 1996 PAC meeting, CIA publicly announced that the 37th Engineering Battalion had destroyed munitions at Khamisiyah in March 1991 and that CIA was 'working with the DoD Investigative Team to resolve whether sarin-filled rockets were destroyed at Bunker 73 and whether some US personnel could have been exposed to chemical agent.' During UNSCOM's inspection of Khamisiyah on 14 May 1996, it was determined that some of the destroyed rockets in Bunker 73 were chemical weapons. ... DoD publicly announced ... [that US forces destroyed

chemical weapons in Bunker 73 and at the "pit"] ... on 21 June 1996.

**Who Was Exposed To What Level Of Sarin As A Result Of Detonating Stacks Of Chemical-Filled 122 Mm Rockets In The Open Pit At Khamisiyah?**

In order to estimate who may have been exposed to sarin as a result of detonations of rockets at the "pit" area of Khamisiyah, we needed to know who was where, how much chemical agent was released by the explosions, and where the agent went. None of this information was directly available. For example, in order to determine who was near Khamisiyah the Army hosted a number of conferences of former operations officers (S-3/G-3s) from the XVIII Airborne Corps and VII Corps to determine where their units were during the early part of March 1991. Before these conferences began, the Army had 233,756 known unit locations, mostly battalions and larger formations. As a result of these conferences, we now have more than twice that number of unit locations for company size units.

We worked to reduce other uncertainties regarding the demolition at Khamisiyah. Together with the CIA, we undertook extensive ground testing at the Army's Dugway Proving Grounds to determine the effects of detonating stacks of chemical-filled 122 mm rockets in the open. We built new computer simulation models by linking old models that incorporated weather information with chemical agent transport models. By combining the results of all of these efforts, we were able to estimate the units most likely to have been exposed and the levels of that exposure. People in those units were individually notified by letter of their possible exposure to low levels of nerve agent.

Approximately one hundred thousand American troops and an unknown number of coalition and Iraqi troops may have been exposed to low levels of sarin as a result of detonating stacks of chemical-filled 122 mm rockets in the open pit at Khamisiyah on 10 March 1991. In July, we notified those who were most likely exposed that

Current medical evidence indicates that long-term health problems are unlikely. The Department of Defense and the Department of Veterans Affairs are committed to gaining a better understanding of the potential health effects of brief, low level nerve agent exposures, and they have funded several projects to learn more about them.

In September and October, we briefed our coalition partners in the Czech Republic, France, the United Kingdom, Kuwait, Saudi Arabia and Egypt and offered to help determine which of their troops may also have been exposed. (We also briefed the Israelis during our trip to the Middle East.)

In total, there have been six reports issued on Khamisiyah by the Office of the Special Assistant and the CIA. An additional report, recently released by the Army Inspector General, substantiates our findings concerning the events that took place at Khamisiyah. Work on the Khamisiyah story continues with a revised case narrative

incorporating all the work done this year, technical reports on the Dugway demonstration and analytic modeling, and a Congressionally mandated report, due in March 1998, on lessons learned by DoD from intelligence operations at Khamisiyah.

## **Operations in Kuwait**

Several other case narratives deal with Marine Corps operations and other reported exposures in Kuwait, which were the subject of testimony before the PAC and Congress. To date, we have traced Marine operations through the minefield at the border of Kuwait and Saudi Arabia, to Al Jaber Air Base and on to an ammunition supply point in an orchard near Kuwait International Airport. Our assessment in each of these cases is that it is "unlikely" that chemical agents were present. We have not said "definitely not present" because some data or information is missing, like the Fox reconnaissance vehicle tapes.

Other cases address several separate incidents at the Port of Al Jubayl that were believed by some veterans to be chemical agent exposures, and a Fox vehicle detection at Camp Monterey after the war. The Al Jubayl incidents were assessed as "unlikely" that chemical warfare agents were present. Our assessment of the event at Camp Monterey is that nerve or mustard agents were "definitely not" present. Analysis of the Fox vehicle tape showed the substance detected at Camp Monterey to be CS, a riot control agent.

To date, the results of our investigations are consistent with the information provided by other governments. In England, and again in Kuwait, government officials told us that the contractors hired after the war to clear mines in Kuwait never reported finding any chemical mines or other chemical munitions, even though it would have been to their financial advantage to make such a report. In addition, UNSCOM testified before the PAC on July 29, 1997 that

In the period from 1996 to 1997 the Commission has undertaken to investigate further the history of the production, filling and deployment of the 155 millimeter mustard shells and also the 122 millimeter sarin rockets.... We now believe Iraq deployed 155 mm mustard rounds and 122 mm sarin rounds during January of 1991...[to] Aukhaider, Nassiriyah, Khamisiyah and the Mymona depot.... We have seen no evidence ... that [weapons were moved from the three lower depots, actually down into Kuwait].

However, we are still piecing this puzzle together incident by incident, and do not yet have a complete picture. Much more work remains to be done before we can say that fallout from the Khamisiyah demolition was the only chemical exposure (albeit low level) our troops suffered while in Kuwait.

## **SIGNIFICANT ACTIVITIES WITH OTHER AGENCIES**

During this year, our office was engaged with other agencies in a number of significant activities that illustrate the type of investigations we have undertaken, the thoroughness of these investigations, and the size of the Government's commitment to "leave no stone unturned." These illustrative activities are:

- The Army IG's investigation of what happened at Khamisiyah.
- The re-creation of the events at Khamisiyah.
- The DoD IG's investigation of the missing CENTCOM Chemical Logs.
- The declassification of important documents relating to possible chemical or biological exposures.

### **Army IG's Investigation Of What Happened At Khamisiyah.**

At the request of the Deputy Secretary of Defense, the Secretary of the Army directed the Inspector General of the United States Army to conduct an inquiry to determine the facts surrounding the demolition of ammunition at the Khamisiyah Ammunition Storage Facility in March 1991. The following is an extract from the report of the Army Inspector General, which is on GulfLINK.

The Department of the Army Inspector General [DAIG] Inquiry Team gathered and assessed over 2000 pages of documents and support materials, to include orders, reports, photographs, video tapes, and operational logs of appropriate CENTCOM units. Visiting twelve major installations, including some located in Korea, Japan, and Germany, the Team interviewed over 700 soldiers, veterans, and civilians, collecting over 300 photos and numerous copies of personal logs and notes. Of the approximately 430 individuals involved in the Khamisiyah demolition operation, the Team interviewed about 250 of them. Coordination was made with agencies ranging from the CIA/DIA to the Office of the Special Assistant for Gulf War Illnesses.

The DAIG Team developed a detailed timeline of the Khamisiyah demolition operation, concluding that no chemical weapons were detected during the operation itself and that force protection measures were generally adequate, although not all soldiers performed to standard when an M8 alarm sounded on 4 March 1991.

The DAIG Team found no empirical evidence that chemical munitions/agents were present during the demolition operation. The Team found no conclusive evidence that US Army ground units either knew or suspected that they were destroying chemical munitions. Physical evidence found later by UNSCOM, supported by a review of available imagery, photos, and intelligence, led the intelligence community and various investigative bodies concerned with Khamisiyah to conclude that chemical munitions were present when the facility was destroyed. The Team likewise found no conclusive evidence that supported or refuted the conclusions of the intelligence community/other investigative bodies.

### **Re-creation Of The Events At The Khamisiyah "Pit"**

DoD and CIA, together with the US Army, worked to estimate the amount of chemical warfare agents released from the Khamisiyah pit. Part of this was extensive field tests at the Army's Dugway Proving Ground and the Edgewood facility in Maryland. The following is extracted from a joint report by CIA and DoD on the Dugway and Edgewood tests which can be found on GulfLINK.

During last year's modeling efforts, we noted that without ground testing we could not estimate with any degree of certainty the amount of agent released at Khamisiyah or the rate of release. In the 1970s, the US conducted additional testing on US chemical rockets to characterize the impact of terrorist actions. Unfortunately, the US tests did not measure the amount of airborne agent downwind and did not help quantify probable release parameters. Thus modelers of the pit demolition were unable to assess whether the agent would be released nearly instantaneously or over a period of days. The later scenario obviously was more dependent on weather conditions.

To resolve these uncertainties, CIA and DoD agreed in April 1997 on the need to perform ground testing before a meaningful computer simulation could be completed. We cooperated to design and implement a series of tests in May 1997 at the Dugway Proving Grounds, which gave us a much better understanding of the events at Khamisiyah. DoD provided complete logistic and administrative support for the tests.

The testing involved a series of detonations of individual rockets and some in stacks, with high-explosive charges placed the way soldiers say they placed them in March 1991. This was done to



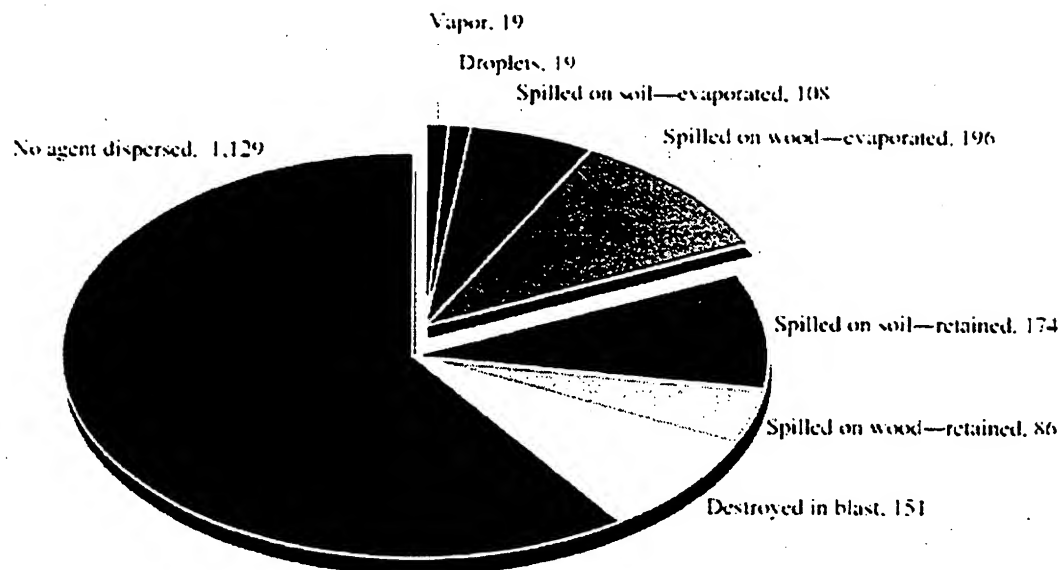
resolve questions like: how did the rockets break? what happened to the agent? were there sympathetic detonations? how much agent might have been released? We could not replicate the entire demolition of hundreds of rockets, but we did gain information critical to our modeling efforts.

First, we took special care in replicating the rockets in the pit, including:

- Using 32 rocket motors identical to those detonated in the pit.
- Manufacturing warheads based on detailed design parameters provided by UNSCOM, including precise wall thickness, materials, and type of burster tube explosive.
- Building crates based on precise measurements and UNSCOM photographs.
- Choosing a chemical agent simulant, triethyl phosphate, that closely simulates the volatility of cyclo-sarin and is often used as a simulant for sarin.
- Stacking the rockets as described by soldiers involved in the pit demolition.

We performed six tests at Dugway using the 32 available rockets. We began with four tests on single rockets in preparation for tests involving nine and 19 rockets. We included a few dummy warheads to increase the size of the stacks. Finally, one of the unbroken rockets from the multiple tests was dropped from an aircraft to simulate a flyout.

The results were very revealing. The only warheads that burst and aerosolized agent were those that had charges placed just beyond the nose of the warhead. Only the warheads immediately adjacent to the charges leaked agent. Even the rocket dropped to simulate a flyout did not disperse any simulant; it buried itself over 30 feet below the surface. The pie chart in figure 6 shows the distribution of agent from these tests among aerosolized vapor and droplets, spill into soil and wood, burning, and unaffected. Only about 32 percent of the agent was released, mostly leaking into the soil and wood. A total of 18 percent became part of the plume—two percent through aerosolization and 16 percent through evaporation (5.75 percent from soil and 10.4 percent from wood).



1,250 rockets x 6.3 kg agent per rocket = 7,875 kg total = 7,125 liters = 1,882 gallons

**Figure 6**

The Dugway testing provided a physical basis for estimating the effect of a charge on the surrounding rockets. We used pressure sensors to refine our gas dynamics models to approximate the threshold forces required to break a warhead. Gas dynamics modeling of the detonations and resultant pressure waves further bolstered our confidence that the results of the Dugway testing were realistic. This allowed development of a model to determine the effect of various placements of charges and orientations of rockets:

- Charges were placed on the ends of rockets opposite the embankment. (As cited in interviews with US soldiers.)
- Charges broke adjacent warheads but not warheads at the other end. (Dugway field testing)
- Evaporation in accordance with Dugway laboratory testing of a 3:1 mixture of sarin/cyclosarin agent at a temperature of 14 degrees C.
- Number of rocket flyouts is low (fewer than 12) with probability of leakage from the rockets minimal. (Soldier interviews and Dugway testing).

We feel confident that the model paradigm is consistent with UNSCOM information, soldier photos, and conservative assumptions. For example, the proportion of rockets whose agent

was not affected during our ground testing (56 percent) closely matched the 708 filled rockets UNSCOM found after the demolition (56 percent). Also, examination of the three known post demolition pit photos of the rockets show very little damage with only 4 out of 36 rockets (11 percent) showing obvious damage.

The large percentage of agent leaking into the soil and wood increased the importance of additional work conducted at Dugway and Edgewood laboratories. The tests were initially planned at Dugway and Edgewood to be performed on soil but, on the basis of the Dugway ground testing results, were expanded to include wood. These tests began by spilling the sarin and cyclosarin mixture onto wood and soil, respectively, and then measuring the rate at which the agent evaporated. The tests also were designed to closely replicate conditions in the pit, including:

- Sarin and cyclosarin—not simulants—were used in a 3:1 ratio.
- Soil, including some from Iraq, which was assessed to be similar to pit sand, was obtained for the tests. We tested pine, a common wood used for 122-mm rocket boxes.
- Tests simulated the wind speeds most likely present during the pit demolitions. Different temperature ranges were used to cover the range of daytime and nighttime temperatures in the pit.

The results of the Dugway laboratory tests ... [show that] most of the chemical warfare agent evaporated during the first 10 hours. Thereafter, with a significantly decreased surface area from spillage, the release was slow, and significant portions of the agent stayed in the soil and wood. In addition, tests of [Khamisiyah type] soil at Edgewood indicated that about one-eighth of the agent degraded in the soil in the first 21 hours.

### **DoD IG's Investigation Of The Missing CENTCOM Chemical Logs**

On March 3, 1997, the Deputy Secretary of Defense directed that the Inspector General, Department of Defense, assume responsibility for an investigation begun in January 1997 by the Office of the Special Assistant to locate missing US Central Command (CENTCOM) Nuclear, Biological and Chemical (NBC) desk logs maintained in the Joint Operations Center (JOC), Riyadh, Saudi Arabia, during the Persian Gulf War. The following is a extract from the report of the DoD Inspector General which is on GulfLINK.

When we assumed control of this investigation from OSAGWI, we learned that investigators from the OSAGWI had compiled an extensive investigative record on the issue of the missing logs. This included interviews of approximately 40 individuals. In-depth interviews of the six NBC officers had been conducted in the January-February 1997 time frame. Also, in late February 1997, OSAGWI investigators visited CENTCOM and conducted interviews of current and former CENTCOM personnel who may have been in possession and/or control of the logs. During that visit, they conducted an office-to-office search of desks and cabinets within CENTCOM, and examined computers and computer disks that may have contained the logs.

This investigation was conducted by the Defense Criminal Investigative Service (DCIS), the criminal investigative arm of the DoD IG. Significant investigative actions included: conducting approximately 185 interviews and a number of polygraph examinations; execution of 3 search warrants; execution of 2 command directed searches at CENTCOM and Aberdeen Proving Ground (APG), MD; document searches by DoD and non-DoD Agencies and organizations; forensic examination of 4 computers and approximately 100 computer disks; the review of more than 700 boxes containing approximately 700,000 pages of archived records at the National Archives and Records Administration (NARA); and the review of more than 22,000 pages of CENTCOM FOIA files.

Based on our investigative effort, we reached the following conclusions:

1. We did not recover any additional pages of the missing logs, in either hard copy or computer form. However, we recovered a significant number of log entries some of which we believe were copied from the still missing pages of the logs. These log entries are contained in the "Log Extracts," which we recovered during a search of personal effects belonging to an Army officer who previously had access to the logs and who is currently under criminal investigation in connection with this matter.
2. The most probable explanation for the missing logs, which were returned to CENTCOM, MacDill Air Force Base, Tampa, in April 1991, is that they were destroyed. This probably occurred in October 1994 or later, after the downsizing and relocation of the CENTCOM J3 NBC office, and after a complete rotation of personnel including original NBC officers who served in the JOC in Saudi Arabia.

3. Despite considerable effort, the computer disk purportedly containing a copy of the logs returned to APG, MD, in March 1991, could not be located.
4. The suspected computer virus that reportedly occurred in the CENTCOM JOC during December 1990 was determined by NSA not to be a computer virus, but a software recognition problem. Even if a computer virus had occurred at that time, as reported, it should not have had an effect on logs created and maintained after the offensive operations commenced on January 17, 1991, and when chemical and biological exposure incidents most likely would have occurred. Therefore, no missing log entries or pages appear to be attributable to a computer virus.
5. Although directives, regulations and internal CENTCOM J1 (Administration) memoranda required that Gulf War records be retained, safeguarded and archived as permanent records, the logs, in their entirety, were not safeguarded and archived by CENTCOM.
6. Our investigation found no credible evidence to support a conspiracy to willfully and wrongfully destroy or dispose of the logs in violation of either the Uniform Code of Military Justice or Title 18, United States Code.

### **Army's Declassification Of Important Health Related Documents**

Since March 1995, the Army has been DoD's Executive Agent for the declassification of Gulf War operational records. As Executive Agent, the Department of the Army provided guidance and coordinated the DoD effort to locate, gather, and review operational records in order to "identify all information pertaining to health problems experienced by veterans of the Persian Gulf War." \*

Each Service issued multiple records calls to ensure that all existing Gulf War operational records were located and collected. The records collected from major headquarters units throughout the services are comprehensive and reasonably complete. However, gaps existed for many smaller units. Therefore, the Army sent search teams to installations with a high density of units that deployed to the Persian Gulf. These search teams went to installations located both in the continental United States and US Army Europe. Further, video-teleconferences were conducted with installations with a low density of units that deployed to the Persian Gulf. As a result of this effort, approximately 560 thousand additional documents were found.

The declassification procedures utilized by the services included state of the art document imaging systems to scan and store Gulf War era records into an electronic database. DoD collected over 6.4 million classified records. These records were searched, 1.1 million were identified as possibly health related,

\*DIA, CIA and other agencies also had ongoing declassification efforts for intelligence documents.

and were forwarded to the OSAGWI team for use in their investigation. Concurrently, these 1.1 million records were further analyzed by the Services and, after eliminating duplicates, records not containing health related information, and mismatches with key words, over 54 thousand were determined to be actually health related and were declassified and placed on GulfLINK. Table 2 shows the breakout of documents by component.

All components listed in Table 2, except for the Air Force, have reported "mission complete." Although the Air Force completed the initial illness tasking in December 1996 as originally mandated by the DEPSECDEF, they are not able to declare full "mission complete" on the overall tasking because new material continues to be found in DoD channels which needs to be reviewed. Along with reviewing all operational Gulf War records for possible declassification and release, the Air Force is also collecting personnel information for inclusion in the US Armed Services Center for Research of Unit Records Gulf War Registry database, and reviewing and cataloguing 1300 video tapes (both Air Force and non-Air Force) received from the Defense Visual Information Center. All services have the capability and are prepared to respond to Gulf War declassification requirements as they arise. In the course of our investigation, we routinely identify material from investigators needing declassification to be used in our narratives. This material is forwarded to the appropriate agency for declassification and returned for our use.

<b>GULF WAR DECLASSIFICATION PROJECT  OPERATIONAL RECORDS COLLECTED BY SERVICE  as of 11/30/97</b>							
<u>Operational Documents</u>	<u>DoD TOTAL</u>	<u>USA</u>	<u>USAF</u>	<u>USN</u>	<u>USMC</u>	<u>CENTCOM</u>	<u>JCS</u>
Total Collected	6.6M	2.3M	2.6M	724.7K	433.3K	500K	30K
Possible Health Related*	1.2M	820.7K	23.2K	160K	169.7K	1.3K	.5K
Actual Health Related**	54.7K	30.3K	13.3K	4.3K	5.9K	.7K	.2K
*Pages that met search criteria based on 270 DoD generated key words. Digitized copies provided to DoD Investigation and Analysis Directorate, SAGWI							
**Pages that contain actual health related information that were declassified and provided to Defense Technical Information Center (DTIC) for posting on GulfLINK. Represents end result after eliminating duplicate records, records not containing health related information, and mismatches.							

**Table 2**

## **LESSONS LEARNED**

For our efforts to have meaningful value, we have to go beyond just investigating and reporting on possible chemical or biological exposures, or even environmental or occupational hazards. We have the responsibility to learn from our experience in the Gulf, including how we handled the post-war investigations. What we have learned can be placed into three groups:

- How to build trust and confidence in DoD
- How to better account for what happened on the battlefield
- How to better protect our people on the battlefield

### **How To Build Trust and Confidence in DoD**

At the start of this report we answered the question, "How did we get into this mess?" by saying: "The best answer that we can give is that, as the crisis over Gulf War illnesses grew, we did not sufficiently listen to the veterans, nor did we provide them with the information they needed to alleviate their fears and answer their questions."

We also noted admonitions that we should not "categorically dismiss" claims that our troops were exposed to chemical agents. In fact, this is the third time in recent history that the Department has had to mount a concerted effort to investigate claims *after* our credibility has been called into question. The previous times concern POW/MIA and Agent Orange from the Vietnam War.

First, we need to be able to provide a full accounting of what happened on the battlefield. This will be discussed below. Second, this accounting cannot just come from the medical establishment. While the veterans are most often concerned about their health, the answer to many of their questions cannot be provided by health professionals alone. Key information can only be provided by those in charge of units in the field. Third, and more importantly, we need to establish and sustain viable communications with concerned individuals and their organizations. As this report shows, investigations are only one part of the many activities of this organization. It is vitally important for the Department to retain credibility with the veterans' community. Reaching out and being responsive to the needs of our veterans is a very important part of our effort and here is the primary lesson regarding credibility: DoD should institutionalize a veterans outreach capability after we have completed our investigations and the Office of the Special Assistant is disestablished.

### **How To Better Account For What Happened On The Battlefield**

The DoD has an absolute responsibility to be able to tell our service members what likely happened on the battlefield, what they may have been exposed to, and the

likely health consequences of those exposures. Re-creating historical events after the fact is always difficult, especially when critical information was not collected and we are not able to retrieve important records.

### **Time and Location Data**

A significant problem has been the lack of data showing where individuals or units were located at any given point in time. Such data is key to determine who may have been exposed to harmful agents, whether in Vietnam, the Gulf, Haiti, Bosnia or some future deployment area. After the Gulf War, Congress mandated that DoD construct a data base to identify where people were during the oil well fires. This was later expanded to track troop locations throughout the theater. The initial efforts, started in 1993, retrieved over six million field records to search one at a time for references to time, place and unit identity. The data base was mainly of battalion-size units. We found this data not specific enough to identify those who may have been exposed to fallout near Khamisiyah in March 1991. Working with the Army, we brought together the former operations officers (S3/G3s) from division and brigade size units to validate the unit location registry and to provide additional company location information from deployment to redeployment. In July 1997, we completed the daily tracking of XVIII Airborne Corps units. We expect to complete the same for VII Corps units and all units under Army Central Command (ARCENT) and its support command by February 1998.

This effort, however, only allows us to know where unit headquarters were located. It does not tell us where individual soldiers were on any given day or during fast moving operations. Collecting such data from hundreds of thousands of soldiers may not be as daunting a task as first seems, given modern electronics and GPS. We asked the Institute for Defense Analyses (IDA), a federally funded research and development center, to investigate the possibility of a non-intrusive battlefield data collection system. They recently published a paper, "Full Dimensional Protection: The Personnel Tracking, Records and Reports Dimension," that identifies significant shortfalls in the Services ability to track the movement of individuals and units on the battlefield and suggests actions to cover these gaps which will be provided to the DoD for appropriate action.

### **Retaining, Safeguarding And Archiving Of Important Records**

Our inability to retrieve records has been both frustrating and a significant factor in the Department's loss of credibility. The efforts by the DoD IG to locate the missing CENTCOM Chemical Logs is an example. The damage done to the credibility of the Defense Department cannot be overstated. Last January, the Senate Veterans Affairs Committee held public hearings to ask General Norman Schwarzkopf if he knew about Khamisiyah, and to review his personal papers to determine if there had been any reference to any chemical incidents during the period that pages from the CENTCOM Chemical Logs were missing. Today, we know from the Army IG's investigation that units at Khamisiyah "did not detect the presence of chemical munitions or chemical agents during the demolition operation [and] made no reports of such a detection." We only know of the presence of chemical agents at Khamisiyah after the fact from



UNSCOM, and recent reviews of imagery, photos, and intelligence, as a result of investigations by DoD and the CIA. We also know from the DoD IG's investigation that there is "no credible evidence to support a conspiracy to willfully and wrongfully destroy or dispose of the logs." Many of these inquiries would have been unnecessary if the log pages had been properly archived, as required. Currently, there is no uniform records management program for Joint Commands. Each command follows the rules and procedures of its host Service at its headquarters installation. The Joint Staff has taken on this issue and established a CINC's Record Management Program to "fast track" the development of new policies and procedures.

Unfortunately, the case of the CENTCOM Chemical Logs is but one example of missing records. We will never know exactly how many records were actually generated and can never accurately estimate how many operational records might exist. Each Service has different regulations concerning the generation, maintenance and disposal of records. Despite numerous requests to search for and forward records, the Army's field visits this year found over one-half million pages of Gulf War era documents that had previously not been reported. CENTCOM also recently discovered documents that have not previously been identified.

There are many organizational factors that have contributed, over the years, to the lack of unit level records, especially turbulence associated with the drawdown during the early 1990s. In the Army, force structure reductions and a desire to maximize the number of soldiers dedicated to warfighting vis-à-vis administration led to the elimination of the company journal, or "morning report", and the company clerks in favor of battalion level administration. This means that records today are less available than they were during World War II or the Korean War. The Army's Force XXI program, a major initiative aimed at transitioning the force into the next century, should provide better record keeping in the future.

### **How To Better Protect Our People On The Battlefield**

The Gulf War has been the subject of numerous studies and many lesson learned exercises. A selection of these are available on GulfLINK. We, too, have identified a number of things that need to be changed as a result of our inquiry into Gulf War illnesses. Many changes are already underway, but many still need to be made. Changes can be categorized into these groups:

- Chemical and biological equipment, especially detectors and alarms
- Medical force protection
- Education concerning the handling of hazardous material

#### **Chemical And Biological Equipment, Especially Detectors And Alarms**

One of the most significant issues arising from the various inquiries concerning possible chemical detections during the Gulf War concerned the prevalence of false alarms. On the battlefield, false alarms often increased the anxiety among our troops and

often resulted in troops either ignoring the alarms or turning them off altogether. When we started our investigations, it was generally understood that M-8 alarms were prone to false alarm, but it was also thought that the Fox NBC Reconnaissance Vehicle with its MM-1 Mobile Mass Spectrometer could not false alarm. (Information Paper is posted on GulfLINK.) Several Fox vehicle crew members testified before Congress and the PAC concerning readings they obtained and questioned why their chain-of-command did not believe that chemical agents were present. Our case narratives clearly explain how a Fox vehicle could generate a false alarm or a false positive reading. The manufacturer, Bruker Analytical Systems, Inc., noted in a letter assessing the false positive report at Camp Monterey that "Since the standard procedure calls for taking a complete spectra and verifying the identification, some false alarms in Air Monitor mode are accepted by the Army to INSURE that there are NO FALSE NEGATIVES where a dangerous agent such as Sarin would not be detected." (Emphasis original) Unfortunately, a complete spectra was almost never taken and Fox Vehicle tapes were almost never retained. Therefore, to confirm that chemical agents were present, it is more often necessary to have confirmatory evidence. In fact, MITRE noted in their "Chapter 11" report (also on GulfLINK) that "in the absence of reported casualties, detections of Sarin vapor reported by the Fox mass spectrometer system in proximity to troops, must be interpreted to imply that (either) only protected personnel (in MOPP4) were in the vicinity of the Fox vehicle when the MM-1 spectrometer detected the Sarin and/or the Sarin detections were in error either because of interferences (e.g. oil well fire smoke) or equipment malfunction."

While we note that there have already been several changes to the Fox vehicle, such as replacing the silicone collection wheels with materials that did not result in false alarms for Lewisite, and other changes are planned such as the installation of the Global Positioning System (GPS) and the addition of the M-21 stand-off chemical detector, there is still no doctrinal requirement to collect and safeguard MM-1 spectrometer tapes.

In the case of the M-8 alarm, many chemical compounds used in either a normal or a military operational environment (i.e. diesel, gasoline exhaust, burning fuel, etc.) can cause this system to false alarm. (Information paper is posted on GulfLINK.) Additionally, operating in unusual or severe environmental conditions, for which the system was not designed, could also cause false alarms. For example, during the Gulf War, high temperatures and sand concentrations often caused this system to false alarm. Operating in unusual or severe conditions can drain the system's power sources, especially the batteries. In turn, low batteries can cause a false alarm. Based on inputs from commanders and lessons learned from Desert Storm, improvements will be incorporated into the M22 Automatic Chemical Agent Detector Alarm (ACADA) which will begin replacing the M8A1 Alarm System in March 1998. This new detector will sense both nerve and mustard agent vapors, and is expected to have fewer false alarm responses to many known interferences—especially gasoline and diesel exhausts.

### **Force Medical Protection**

Force medical protection during the Gulf War was implemented in varying degrees, but was neither standardized nor centralized among deployed forces. For

example, in September 1990, the Navy established a laboratory, known as the Navy Forward Laboratory (NFL) at the Marine Corps Hospital in Al Jubayl, Saudi Arabia. The effort was supported by the Bureau of Medicine and Surgery, and drew upon many assets (people, equipment, expertise) from several Navy medical research and preventive medicine activities OCONUS and CONUS. (The story of the Navy Forward Laboratory is available in an information paper on medical surveillance on GulfLINK.) The NFL developed into a state-of-the-art infectious disease diagnostic laboratory that had the capabilities of a well-equipped laboratory in CONUS. When fully operational, the NFL became a theater-wide, infectious diseases reference laboratory. Other Services, however, did not establish similar facilities in theater.

After the war, the Assistant Secretary of Defense for Health Affairs and the Joint Staff undertook a complete review of doctrine, policy, oversight and operational practices for medical surveillance and force medical protection. Changes were applied to subsequent deployments to Somalia, Rwanda, Haiti, and Bosnia, and modified accordingly. Recently, OSD/Health Affairs and the Director of the Joint Staff announced the development of a comprehensive force medical protection strategy. This approach to force medical protection throughout the deployment continuum has been adopted within Presidential Review Directive NSTC-5, "Development of Interagency Plans to Address Health Preparedness for and Readjustment of Veterans and Their Families After Future Deployments." Joint publications are being revised to reflect changes in doctrine. Theater operations plans are being revised to include appropriate force medical protection measures. Ultimately, of course, support of force medical protection programs is the responsibility of theater and joint task force commanders.

One very important change will be the new Personal Information Carrier (PIC), a small dog-tag-like computer storage device that will store medical information, including patient history, treatments, and vaccination records. Historically, medical record keeping has been less than perfect, especially during deployments. One very frustrating issue with veterans is their inability to retrieve their medical records. At best, in their view, this makes it difficult to establish a service connection on health claims, and, at worst, it is added proof that the Department is withholding critical information. The PIC will be only one part of a full electronic theater medical record system to ensure that medical records are not lost.

Individual health information between the VA and DoD is currently incompatible. Creating the ability to electronically transfer data between the two Departments and/or creating a database that is compatible with the VA's would be of benefit to the veterans and could reduce the cost associated with adjudication of claims. Through a joint DoD/VA Executive committee, a number of initiatives are underway. One is to set up procedures for the transfer of a wide range of health information, regardless of whether or not the respective data systems are compatible. A second initiative is to agree to a common discharge physical and the medical information collected as part of the physical. The third is to jointly acquire a computerized patient record system that would be used by both Departments.

In addition to these actions, Deputy Secretary of Defense John White commissioned a special advisory panel of the National Academy of Sciences to review

and advise DoD on our medical force protection program. Their work is just getting underway.

### **Education Concerning How to Handle Hazards Materials**

Our investigations into potential health hazards of depleted uranium (DU) point to serious deficiencies in what our troops understood about the health effects DU posed on the battlefield. These hazards were well documented as a result of the Army's exhaustive developmental process for fielding DU munitions. Unfortunately, this information was generally known only by technical specialists in nuclear-biological-chemical health and safety fields. Combat troops or those carrying out support functions generally did not know that DU contaminated equipment, such as enemy vehicles struck by DU rounds, required special handling. Similarly, few troops were told of the more serious threat of radium contamination from broken gauges on Iraq's Soviet-built tanks. The failure to properly disseminate such information to troops at all levels may have resulted in thousands of unnecessary exposures.

On September 9, 1997, we wrote to the chiefs of the Air Force, Navy and Marines encouraging them to "ensure that all Service personnel who may come in contact with DU, especially on the battlefield, are thoroughly trained in how to handle it." The requirement for training extends beyond the normal basic and technical training and should be provided to all members of the force. We are currently working with the Joint Staff to ensure that all service personnel who might come into contact with DU (e.g., combat and support personnel and anyone deployed to a theater where DU might be used) receive appropriate training on how to handle DU and DU contaminated equipment.

### **PUTTING THE OFFICE OF THE SPECIAL ASSISTANT IN PERSPECTIVE**

The Office of the Special Assistant for Gulf War Illnesses has accomplished a great deal this year; however, we are not the only organization addressing Gulf War issues. Throughout the Government, many have made significant efforts and deserve to be recognized.

- The Presidential Advisory Committee stimulated DoD to improve its efforts and provided oversight which led to a review of our standards and methods. Although we have had our differences, we recognize their dedication to helping our veterans.
- The Assistant Secretary of Defense (Health Affairs) shares with us the common mission to ensure our service men and women receive the care they need. Health Affairs maintains the Comprehensive Clinical Evaluation Program, which provides medical examinations to our veterans. Additionally, they manage the Department's Gulf War related medical research program, and, with the JCS, they have the lead in the medical force protection program
- The DoD Inspector General's investigation into the missing CENTCOM nuclear, biological and chemical logs and the Army Inspector General's

investigation into the events at Khamisiyah were important independent efforts.

- The Assistant to the Secretary of Defense (Nuclear, Chemical and Biological Defense Programs) provides expert advice on chemical and biological warfare issues, especially on the tests at Dugway Proving Grounds.
- The Assistant Secretaries of Defense for Legislative Affairs and for Public Affairs and their staffs provided invaluable support.
- The DoD Comptroller has provided the resources needed to undertake a complete and thorough investigation.
- The Army's support has been outstanding from the declassification project implementation of a state-of-the-art facility to review, declassify, and archive documentation, to organizing the S3/G3 conferences.
- The Department of Veterans Affairs and the Department of Health and Human Services worked with us through the Persian Gulf Veterans' Coordinating Board to address interagency solutions, especially on medical research.
- The Central Intelligence Agency and the Defense Intelligence Agency have been valued partners working with us on a daily basis in our common search for answers.
- Most importantly, the National Security Council Staff has coordinated the work of all government agencies in a very effective manner. The Special Assistant to the President and Senior Director for Gulf War Illnesses issues has provided outstanding leadership.

This has truly been a Government-wide effort. We have all adhered to the President's charge to "leave no stone unturned," not just because he told us to, but because we are all dedicated to do whatever it takes to support those who served so bravely during the Gulf War.

## **NEXT YEAR**

Establishing the Office of the Special Assistant was a significant commitment by the Defense Department to the Government-wide effort to support those who served in the Gulf War. Significant progress was made during our first year in investigating specific claims that our troops were exposed to chemical agents, and to better understand the events and fallout from the demolitions at Khamisiyah. As we look ahead, the following are the planned and on-going activities that will take us into our second year:

- Complete and publish as "interim reports" twelve additional chemical case narratives, three additional information papers and updates to two previously published case narratives.
- Complete and publish three reports each on pesticides, depleted uranium (DU) and the fallout from oil well fires. My office will review what happened in the Gulf and identify a number of likely "exposure scenarios." The Army's CHPPM will attempt to estimate the possible dose rate for each of the

exposure scenarios. RAND will review what medical science says about the danger from these exposures.

- Complete our investigation of the Air Campaign, including a detailed analysis of possible fallout using the same models used to estimate the fallout from the Khamisiyah demolitions.
- Conduct an analysis of Army in-theater hospital records.
- Conduct an extensive inquiry into the possibility that Iraq used biological warfare agents.
- Exploit contacts made during our Middle East trip, particularly with the Saudi Arabian National Guard concerning research on any changes in the health status of the indigenous Saudi population after the Gulf War
- Expand our outreach program to cover the "Total Force;" those currently on active duty and members of the National Guard and Reserve components.
- Monitor programs in place as a result of lessons learned to date; e.g., DU training by the Services, as well as the continuing effort to archive and declassify health related Gulf War documents
- IDA will complete research into low level chemical doctrine and publish several papers applicable throughout DoD.
- RAND will complete and publish eight medical reviews, as well as two papers on management of our medical program.
- Several medical research projects we have been monitoring closely will report during our second year. Most notable being the review of Dr. Garth Nicolson's techniques for detecting the presence of *Mycoplasma fermentans* (incognitus strain).
- The S3/G3 conferences will be completed by the end of February 1998. As a result, we will be better able to determine the number of personnel exposed to low level chemical agents at Khamisiyah. We will also incorporate information about the location of Air Force personnel.

If our first year is any guide, additional reviews will come up during the year that cannot now be anticipated. We look forward to the challenges ahead and to working and cooperating with the President's Special Oversight Board to be chaired by former senator Warren G. Rudman. I expect, by the end of next year, that we will have completed all major investigations into possible chemical and biological exposures and a number of significant environmental hazards, and can start to draw down the Office of the Special Assistant. A residual effort will be needed to continue to meet the needs of our veterans, e.g., to continue GulfLINK and other outreach programs, and to maintain a focal point in the Department of Defense on issues of Gulf War illnesses.

# DEPARTMENT OF DEFENSE



## COMPREHENSIVE CLINICAL EVALUATION PROGRAM

FOR

PERSIAN GULF WAR VETERANS

*CCEP Report on 18,598 Participants*

April 2, 1996

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# EXECUTIVE SUMMARY

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Approximately 697,000 U.S. service members deployed to the Persian Gulf in 1990/1991 for Operations Desert Shield/Storm (ODS/S). The vast majority of troops returned from this large deployment healthy. In response to Gulf War veterans' concerns about the potential health effects of service in ODS/S, the Departments of Defense (DoD) and Veterans Affairs (VA) developed similar, clinical evaluation programs to provide them care and to understand the nature of their illnesses. The DoD Comprehensive Clinical Evaluation Program (CCEP) provides a systematic, in-depth medical evaluation for DoD beneficiaries (Persian Gulf War veterans now on active duty or retired; members of the full-time National Guard who are Persian Gulf veterans; Persian Gulf War veterans who are members of the Ready Reserve/Individual Ready Reserve/Standby Reserve/Reserve who are placed on orders by their units; and eligible family members of such personnel) who are experiencing illnesses that may be related to their service in the Persian Gulf. As of early December 1995, more than 27,000 individuals had enrolled in the program. Approximately 21,000 of these participants requested an examination of which 18,598 had completed the evaluation process and had the information about their health verified and entered into the CCEP database.

This descriptive case series report summarizes the diagnostic results of over 18,000 systematic clinical evaluations completed through the CCEP. The CCEP was designed primarily as a clinical rather than a research program. Self-selection of patients, recall bias, inability to validate self-reported exposures, and the lack of an appropriate comparison or control group limit the ability to generalize the CCEP findings to other Persian Gulf veterans. However, the large size of the CCEP cohort and the thoroughness of the CCEP examinations provide considerable clinical insight towards understanding the nature of these veterans' illnesses and health concerns. Ongoing and planned epidemiologic studies by the Department of Defense, Veterans Affairs, and Health and Human Services which involve control/comparison populations, will characterize further any health consequences of the Persian Gulf War.

Based on the evaluation of 18,598 participants, our findings include:

- CCEP participants report a wide variety of symptoms spanning multiple organ systems in no consistent, clinically apparent pattern. In the clinical literature, only a limited number of studies of symptoms of patients in other clinical and survey settings have been published. These other study populations are not completely analogous to the CCEP population, since they generally involve older patients and more women than found in the CCEP. However, these studies of outpatient practice and the general U.S. population suggest that the types of symptoms being reported in the CCEP are not unique and are similar in nature to those seen in other groups of patients.
- Symptoms such as fatigue, joint pain, headache, or sleep disturbances are common among CCEP participants. Published studies involving patients with these types of generalized symptoms have shown that 20-75% of them lack a clear-cut or discrete physical explanation or "cause" after a thorough medical evaluation. Similarly, it is likely that some CCEP participants may also lack a discrete physical explanation for their generalized symptoms.
- The distribution of primary diagnoses seen in CCEP participants spans many different organ systems as categorized according to the International Classification of Diseases-Ninth Revision, Clinical Modification (ICD-9-CM). However, over half (65%) of the primary diagnoses of CCEP participants are concentrated in four diagnostic groups: "Psychological Conditions," "Symptoms, Signs, Ill-Defined Conditions," "Musculoskeletal and Connective Tissue Diseases" and "Healthy" (V65.5).
- Gulf War veterans who have participated in the CCEP are experiencing real symptoms and illnesses with real consequences, although the vast majority of participants are apparently able to function in their jobs. Severe disability, measured in terms of reported lost workdays, is not a major characteristic of CCEP participants. Relatively few CCEP participants report missing work because of illness or injury during the 90 days prior to

their initial evaluation. Determination of the extent to which the CCEP disability experience reflects the overall disability experience of Persian Gulf veterans is limited by the fact that many Persian Gulf War veterans are no longer on active duty.

- Comparisons of CCEP participants with patients in outpatient medical settings are limited because of differences in patient populations. However, some existing clinical studies provide a context in which to consider the following CCEP findings.
  - The most common psychological conditions found in CCEP participants are: tension headache; nonspecific, mild, or stress-related anxiety and/or depression; and posttraumatic stress disorder (PTSD). The prevalence of psychological diagnoses among CCEP participants may be higher than that observed in other patients seen in general medical practice.
  - CCEP diagnoses include a group of common medical conditions not classified elsewhere in the ICD-9-CM coding system (e.g., sleep apneas), generalized symptoms, abnormal laboratory tests, and nonspecific physical findings. These diagnoses, which are categorized as "Symptoms, Signs and Ill-Defined Conditions" according to the ICD-9-CM coding system, may occur more frequently in the CCEP than among patients seen in general medical practice.
  - Musculoskeletal and connective tissue diseases (joint pain, osteoarthritis, backache) are common diagnoses seen in CCEP participants. These conditions appear to occur more frequently in the CCEP population than they do in patients seen in general medical practice.
- The evaluation of reproductive risks to men and women from environmental exposures is a complex and emotional issue. Some CCEP participants self-report experiencing adverse reproductive events since the Gulf War. However, these reports have not been validated by review of medical records or other sources of information. Reproductive studies of other groups of Persian Gulf veterans, which have involved review of medical



records and related databases, have to date found no evidence of increased reproductive problems. Clearly this is an important issue, which the Department will study further.

- To date, there is no clinical evidence for a previously unknown, serious illness or “syndrome” among Persian Gulf veterans participating in the CCEP. A unique illness or syndrome among Persian Gulf veterans evaluated through the CCEP, capable of causing serious impairment in a high proportion of veterans at risk, would probably be detectable in the population of 18,598 patients. However, an unknown illness or a syndrome that was mild or affected only a small proportion of veterans at risk might not be detectable in a case series, no matter how large.

DoD will continue to provide comprehensive high quality health care to eligible Persian Gulf veterans and their family members and will continue its efforts to understand any health consequences of service in the Persian Gulf War. The Department is committed to a continuing exchange of relevant information with other government agencies, researchers, and Gulf War veterans to further understand this important public health issue.

# BACKGROUND

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## Introduction

Iraq invaded Kuwait on August 2, 1990. Subsequent implementation of Operation Desert Shield occurred at a rapid pace, and approximately 697,000 U.S. service members were deployed to the Persian Gulf region over the next five months. Fortunately, hostilities did not begin immediately, and medical personnel had an opportunity to assess medical threats, formulate effective surveillance efforts, and design preventive programs to keep non-battle morbidity and mortality at the lowest possible levels.<sup>1,2</sup> By the time Operation Desert Storm began in January 1991, the soldiers, sailors, airmen, and marines in this operation were, in many respects, more closely monitored for the emergence of medical problems, and better protected from environmental threats, than service members in any previous campaign. These measures were successful; the Gulf War had a lower disease non-battle injury (DNBI) rate than any major conflict in U.S. history.<sup>3,4</sup>

Since Operations Desert Shield/Storm (ODS/S), some Gulf War veterans have reported persistent symptoms that they believe are related to their experience in the Persian Gulf War. These symptoms most commonly included fatigue, joint pain, sleep problems, loss of memory, rash, or headache. In response to veterans' concerns about their health following ODS/S, the Departments of Defense (DoD) and Veterans Affairs (VA) developed similar comprehensive clinical evaluation programs. As of early December 1995, the DoD had enrolled over 27,000 participants eligible for DoD health care in the Comprehensive Clinical Evaluation Program (CCEP).

In December 1994, the DoD issued its preliminary status report on the first 1,000 patients to complete the CCEP.<sup>5</sup> Since that report, the Department has continued an aggressive outreach

effort to provide evaluation and care to veterans who are experiencing illnesses that they feel may be related to their service in the Persian Gulf. On March 10, 1995, the DoD provided updates of the results of 2,076 medical evaluations accomplished through the CCEP<sup>6</sup> and in August 1995 presented a report on 10,020 participants.<sup>7</sup> This report summarizes program activities through December 6, 1995, and includes the clinical findings from 18,598 participants who have requested and completed their CCEP evaluations. Additionally, this report updates information provided in previous reports and presents recent results from the CCEP in order to further describe the clinical characteristics of CCEP participants.

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## **Potential Health Risks Associated with Persian Gulf Deployment**

A number of questions have arisen about the possible impact of certain environmental exposures and preventive medicine measures on service members during ODS/S. To better understand the health concerns among Gulf War veterans and provide the most effective treatments of their illnesses, a review of potential health risks associated with service in the Persian Gulf is necessary. These risks include physical and psychological stress, possible reactions to prophylactic drugs and vaccines, infectious diseases, and exposures to environmental hazards.<sup>8</sup> In addition, there has been a concern among some veterans that chemical and biological weapons may be associated with some of their symptoms. As observed in studies of veterans of other wars, readjustment disorders and posttraumatic stress disorder (PTSD) have been common problems among Persian Gulf veterans.<sup>9,10,11,12,13</sup>

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## **DoD Actions and Initiatives**

The DoD began to assess the health consequences of the Persian Gulf War while troops were still deployed in the Gulf region. As early as February 1991 a medical workshop convened in Dayton, Ohio, to consider the medical effects that might occur among troops exposed to crude oil released from damaged wells during the course of Operation Desert Storm.<sup>14</sup> In May 1991 the DoD deployed a team of physicians, scientists, and engineers to the Persian Gulf region to

establish monitoring stations in both Kuwait and Saudi Arabia to assess the potential environmental health risks to service members. The Kuwaiti Oil Fire Health Effects Working Group was formed in August 1991 to provide technical oversight of the Department's efforts to conduct a comprehensive health risk assessment of effects of exposures to smoke from the Kuwaiti oil well fires.<sup>15</sup> Additionally, an Expert Panel on Petroleum Toxicity met in June 1991 at the Uniformed Services University of Health Sciences (USUHS) to review and discuss scientific information pertaining to health effects that might be expected to result from exposure to the oil well fires.<sup>16</sup>

While these scientific/technical reviews were in progress, the Department was also conducting field investigations of groups of veterans with health complaints. During 1992 "clusters" of military personnel presented with nonspecific symptoms they attributed to their Gulf War service, which resulted in two field investigations. The Army investigated one such cluster among members of the 123rd Army Reserve Command in Indiana. In April 1992 the investigators concluded that the paucity of abnormal physical or laboratory findings, the types of symptoms reported, the association of onset of symptoms with redeployment, and the results of the psychiatric evaluation suggested that many of the symptoms were likely to be stress-related.<sup>17</sup> The Navy conducted a similar investigation of a reserve Seabee battalion (Naval Reserve Mobile Construction Battalion 24) from November 1993 to October 1994. Many members of this unit complained of symptoms that they believed were related to their service in the Persian Gulf. Although investigators confirmed that a significant number of individuals had experienced an array of nonspecific symptoms since returning from the Gulf, no common syndrome or diagnosis was identified in this group of veterans.<sup>18</sup>

Initially, the three Services began to identify military members with possible Gulf War-related medical conditions through routine health surveillance programs designed to track reportable diseases. In August 1992 the Army Surgeon General directed clinicians to identify individuals with medical conditions that might be related to service in the Persian Gulf. In October 1992 the Assistant Secretary of Defense (Health Affairs) requested the Services to provide reports of the numbers of personnel who had been evaluated for complaints attributed to service in the Persian

Gulf. By April 1993 a total of 264 individuals were reported by the three Services. The diseases reported were distributed across 62 different categories. By January 1994 the Services had identified approximately 400 individuals with Gulf War-related health complaints and/or medical problems.

Concurrent with clinical activities and preliminary epidemiological field investigations, the Department organized several independent reviews of health issues involving Persian Gulf veterans. In September 1993 the Army Surgeon General enlisted the assistance of Dr. Jay Sanford, an expert in infectious diseases and former president of the USUHS, to assess clinical case histories of Gulf War veterans. The goal was to define a standard symptom complex to aid physicians in diagnosis. Dr. Sanford completed his review and submitted his preliminary findings on January 27, 1994. Dr. Sanford concluded that the cases available for review at the time lacked the consistent clinical findings necessary to establish a case definition which meets the criteria of being sensitive enough to identify individuals with a new illness but specific enough to exclude individuals with other known illnesses.<sup>19</sup>

By late 1993 it had become evident to the Department that there was a need to have independent scientific bodies review the development of "unexplained illnesses" among Gulf War veterans. In February 1994 the Department tasked the Defense Science Board (DSB) to examine the possible exposure of personnel to chemical and biological weapons agents and other hazardous material during the Gulf War and its aftermath. The DSB Task Force on Persian Gulf War Health Effect, chaired by Dr. Joshua Lederberg, a Nobel laureate, concluded in its June 1994 report that "there is no persuasive evidence that any of the proposed etiologies caused chronic illness on a significant basis."<sup>4</sup> The National Institutes of Health (NIH) Technical Assessment Workshop on the Persian Gulf Experience and Health, a panel of non-federal experts formed to assess existing data on the "unexplained illnesses" being reported by Persian Gulf veterans, was convened from April 27-29, 1994, by the DoD, VA, and Department of Health and Human Services (HHS). Among its conclusions, the panel indicated that "the complex biological, chemical, physical, and psychosocial environment of the Persian Gulf theater of operations

appears to have produced complex, adverse health effects ... there is no single disease or syndrome apparent, but rather multiple illnesses with overlapping symptoms and causes."<sup>20</sup>

In response to the magnitude of veterans' concerns and the uncertainty surrounding the nature of some of their illnesses, the Assistant Secretary of Defense (Health Affairs) announced a three-point plan, on May 11, 1994.<sup>21</sup> The plan included:

1. The development of an aggressive, comprehensive, clinical diagnostic program to offer intensive examinations to veterans who do not have clearly defined diagnoses,
2. An initial independent review of DoD clinical and research efforts concerning the Persian Gulf War by Dr. Harrison C. Spencer, Dean of The Tulane School of Public Health and Tropical Medicine, New Orleans, Louisiana, and
3. The creation of a forum of national medical and public health experts to review, comment, and advise DoD concerning the results of the clinical evaluation program.

This plan represents the Department's fundamental approach to meeting the health needs of Gulf War veterans. The CCEP offers in-depth medical examinations through a program which provides prioritized access to clinical care through the Military Health Services System (MHSS). Dr. Spencer of Tulane provided an initial review of the issue of "unexplained illnesses" and recommended development of a standardized clinical protocol even in the absence of a specific case definition. External review of the Department's clinical program, both design and implementation, has been a key component in the overall approach to providing care to Gulf War veterans. External scientific review has been provided by the Institute of Medicine (IOM), National Academy of Sciences. The IOM Committee on the DoD Persian Gulf Syndrome Comprehensive Clinical Evaluation Program has provided ongoing consultation regarding the CCEP. DoD clinicians have presented the results from the CCEP to the IOM expert committee on three occasions. This collaborative process has proven successful in enhancing the quality of care provided through the CCEP and in characterizing the clinical nature of illnesses being experienced by CCEP participants.

## **CCEP Specialized Care Center (SCC)**

A Specialized Care Center (SCC) opened at Walter Reed Army Medical Center in March 1995 for the intensive treatment of symptomatic Persian Gulf War veterans. Referrals are accepted from clinicians who have evaluated veterans in the CCEP. Clinicians are requested to refer motivated individuals to the SCC who are suffering from persistent symptoms that interfere with their ability to perform their duty or to meet fitness and retention standards.

Patients come to the SCC for four-week treatment periods in groups of four to six and reside on the grounds of Walter Reed as outpatients. They receive treatment from a multidisciplinary team that includes fitness trainers, nutritionists, occupational and physical therapists, art and recreation therapists, internists, social workers, psychiatrists, and psychologists. The program is rigorous, beginning at 0600 each morning and extending into the evening.

Thirty-five veterans have entered the program, with only one failing to complete the four weeks. Five patients have completed a program specifically tailored to veterans with PTSD. Nearly all patients have shown improvement in their health and a significant improvement in their level of fitness. The latter is demonstrated by an average two-minute decrease in the time required to complete a two-mile run. Although not overwhelmed with patients, the SCC continues to accept referrals as needed. A second SCC is scheduled to open at Wilford Hall Medical Center, Lackland AFB, Texas in mid 1996. Patients who have completed the SCC programs will receive follow-up as clinically indicated.

## **Institute of Medicine Review**

As noted above, the Department of Defense asked the IOM to establish a committee to evaluate the CCEP. The IOM was chartered in 1970 by the National Academy of Sciences to enlist distinguished members of appropriate professions to examine policy pertaining to the health of the public. The IOM Committee has reviewed the clinical evaluation protocol and commented on the interpretation of the CCEP results. In addition, the Committee has provided

recommendations relevant to the conduct of the clinical evaluations in the future. The Committee's recent report, released January 4, 1996, included the following recommendations and comments:<sup>22</sup>

- The CCEP clinical protocol is a thorough, systematic approach to the diagnosis of a wide spectrum of diseases.
- The DoD is encouraged to emphasize in its future reports psychosocial stressors that can produce physical and psychological effects.
- There is currently no clinical evidence in the CCEP for a previously unknown, serious illness among Persian Gulf War (PGW) veterans. Several large research studies currently being conducted by DoD and the VA may provide more definitive answers as to the possibility of a new or unique Persian Gulf syndrome.
- Interpretations based on comparisons with other populations should be made with great caution and only with the explicit recognition of the limitations of the CCEP as a self-selected case series.
- The results of the CCEP can and should be used for several purposes, including education, improving the medical protocol itself, and evaluating patient outcomes.

### **Persian Gulf Veterans' Coordinating Board**

The Persian Gulf Veterans Coordinating Board, consisting of the Secretaries of Defense, Veterans Affairs, and Health and Human Services was established on January 21, 1994 by President Clinton to merge the expertise and capabilities of the departments and coordinate all efforts on behalf of Persian Gulf veterans. The Coordinating Board is composed of three working groups with representation from each of the agencies that focus on issues of research, clinical care, disability evaluation and compensation.



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## What's New in This Report

Since June 1994 over 19,000 Persian Gulf veterans have completed medical evaluations within the DoD CCEP worldwide. This report encompasses the results on 18,598 CCEP participants and is largely consistent with results of previous CCEP reports. For example, the frequency distribution of self-reported exposures, symptoms and diagnoses have remained relatively constant since the CCEP began.

This report reflects recommendations from the IOM and other consultants to DoD. Areas that have been explored in greater detail include analysis of a subpopulation of the National Ambulatory Medical Care Survey (NAMCS), which resembles the CCEP population in terms of sex and age; characterization in greater detail of those individuals with more than one diagnosis; an evaluation of disability associated with CCEP participants; analysis and examination of the reproductive questionnaire that was introduced in January 1995; review of the distribution of diagnostic categories over time intervals; and further analysis of unit identification codes (UICs) as a surrogate measure of occupational exposure and location within the Persian Gulf theater of operation.

# METHODS

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Participants may enroll in the CCEP by calling a toll-free number (1-800-796-9699), which provides information and referrals to individuals requesting medical evaluations or by contacting their local military medical treatment facility (MTF). All MHSS eligible beneficiaries are eligible for the CCEP. For eligibility in the CCEP, a PGW veteran (or dependent) must have been eligible for DoD health care in June 1994 or later.

Once an individual is referred, the CCEP provides a two-phase, comprehensive medical evaluation, with Phase I being conducted at one of 184 local MTFs. Phase II (when required) is conducted at one of 14 regional medical centers (RMCs). The medical review includes questions about family history, health, occupation, and unique exposures in the Gulf War, as well as a structured review of symptoms.

Once a participant has completed the examination process, copies of examination results are forwarded to the CCEP Program Management Team (PMT), where they undergo quality assurance procedures, and the data are entered into the master CCEP database.

Additionally, for those CCEP participants suffering from chronic, debilitating symptoms, the DoD has established an SCC at Walter Reed Army Medical Center and will have a second center opening in mid 1996 at Wilford Hall Medical Center, Lackland AFB, Texas.

The data, which were initially entered into a relational database, were translated into a statistical format for this report. Various validity checks were conducted to ensure that the data were appropriate for interpretation. Statistical tests and descriptive analyses were conducted on various categories of participants, including those in theater during the Persian Gulf War, their spouses, and their children. Moreover, the CCEP participants who were in theater were compared to the PGW population as a whole and were stratified by units to compare those units

with higher CCEP participation to those units with lower CCEP participation. Specific analyses concerning self-reported exposures, physician-elicited symptoms, diagnoses, self-reported reproductive outcomes, self-reported lost workdays, physical evaluation boards (PEBs), and program satisfaction were conducted. Additionally, a comparative analysis with the NAMCS data was conducted using age, sex, race, ethnicity, and diagnostic code variables to more closely match the CCEP population.

See Appendix B for more specific information regarding the methods used in data analyses.

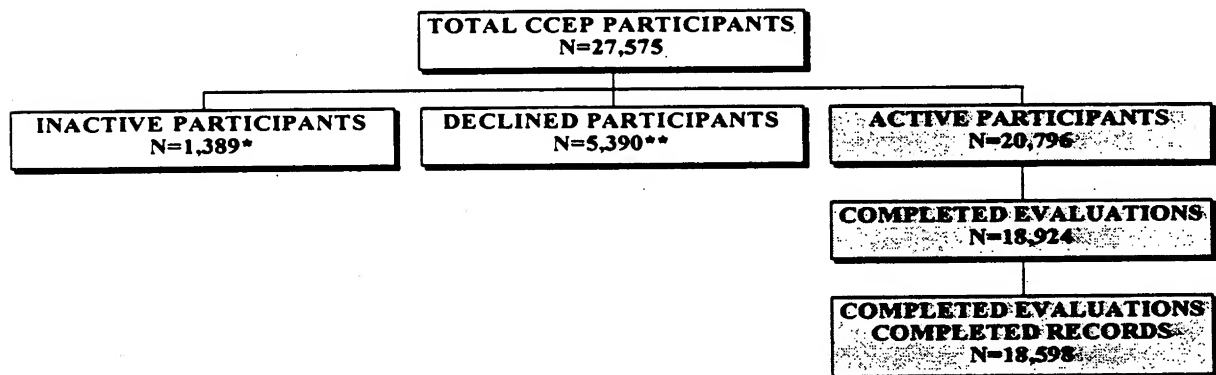
# RESULTS

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## Program Status

Figure 1 summarizes the categories of CCEP participants as of early December 1995. Of the 20,796 participants who requested medical examinations through the CCEP, 18,598 records have been entered into the CCEP computerized database (Figure 1). Eighty-seven percent (87%) of CCEP evaluations were completed at Phase I and 13% at Phase II.

**Figure 1. Disposition of CCEP Participants as of December 6, 1995**



\* Inactive Participants include those participants who wish to defer their medical evaluation until a later time.

\*\* Declined Participants are those participants who have determined that they do not desire to undergo the evaluation process (but do desire to be registered in program) and subsequently signed a declination form OR are those participants who have not responded to the repeated phone calls/certified return receipt letters requesting that they contact their local CCEP Administrator in order to schedule an appointment to begin or continue their examination process.

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## Demographics

Demographic characteristics of the in-theater CCEP participants are shown in Table 1 along with comparable data for the total PGW participants. The total PGW participants are defined as all active duty personnel plus all Reserves/Guard who were actually in the Gulf War theater. The Army is more heavily represented in the CCEP database than other military branches. Also, higher percentages of women and blacks are found in the CCEP database when compared to all PGW participants. The age distribution of CCEP participants differs from the total Gulf War participants in that the CCEP participants have a higher percentage of individuals in the two oldest age groups (44.3%) than the total PGW participants (28%). With the exception of the youngest age group, the CCEP participants are spread approximately uniformly across the remaining four groups.

**Table 1. Demographic Characteristics of CCEP Participants and Persian Gulf War Participants**

Characteristics	CCEP Participants N=18,075 <sup>#</sup>	Total PGW Participants N=697,000*
Gender(%)		
Male	88	93
Female	12	7
Race(%)		
White	57	70
Black	32	23
Hispanic	6	5
Other/No Data	5	2
Age		
Mean	30	26 <sup>†</sup>
Median	29	24 <sup>†</sup>
In Groups(%)		
17-20	10	11
21-25	23	38
26-30	23	22
31-35	22	13
36-65	22	15
Other/No Data	1	
Rank(%)		
Enlisted	88	89
Officer	11	10
Other/No Data	1	1
Branch(%)		
Air Force	10	12
Army	81	50
Marines	4	15
Navy	4	23
Other/No Data	1	---
Status(%)		
Active	83	83
Reserve Component <sup>††</sup>	13	17
Other/No Data	4	---

# Includes only CCEP members in theater.

\* Source: Desert Shield/Storm Participation Report Vols. 1 & 2. Defense Manpower Data Center, DoD, 1994.

† Participant's Age as of 2 August 1990.

†† Because most RC PGW participants are not military health care beneficiaries, these differences are expected.

‡ Mean and median age and marital status for PGW veterans are for Active Component members only.

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## Self-Reported Exposures

The self-reported responses to a checklist of 25 exposures are summarized in Table 2. Most participants reported at least one exposure. Only 0.2% of CCEP participants reported no exposure. The median number of self-reported exposures was ten.

The most frequent self-reported environmental exposures include passive cigarette smoke (88%), diesel/other fuels (88%), pyridostigmine bromide tablets (74%), oil smoke (71%), tent/heater fumes (70%), and personal pesticide use (66%). Least often self-reported exposures were suspected nerve gas/nerve agents (6%), suspected mustard/blistering agents (2%) and wounded in combat (2%). Nearly one-third (31%) of the CCEP in-theater participants indicate they are current smokers, smoking an average of 15 cigarettes per day.

Five questions were related to exposures associated with combat. Ten percent of the participants reported none of these, 40% reported one or two, and 21% four or five. The most frequently reported of these exposures were witnessing a chemical alarm, witnessing a casualty, and witnessing SCUD attacks. Only 2% self-reported being wounded in combat.

**Table 2. Self-Reported Exposure History (N=18,075)**

Exposures Recalled By Participants	Response	
	Number	Percent*
Cigarette Smoke (Passive)	15,993	88
Diesel/Other Fuels	15,910	88
Pyridostigmine Bromide	13,287	74
Oil Fire Smoke	12,763	71
Tent/Heater Fumes	12,651	70
Personal Pesticide Use	11,891	66
Ate Non-U.S. Foods	11,848	66
Had Anthrax Immunization	8,881	49
Solvent	8,708	48
Chemical Agent Resistant Coating (CARC) Paint	8,444	47
Other Paint	7,755	43
Microwaves	6,124	34
Bathed in/Drank Non-U.S. Water	5,835	32
Had Botulism Immunization	4,696	26
Took Oral Medicine to Prevent Malaria	3,926	22
Ate Contaminated Food	3,773	21
Bathed in Contaminated Water	3,579	20
Depleted Uranium	2,793	15
Nerve Gas/Nerve Agents	1,056	6
Mustard Gas/Blistering Agents	429	2
Chemical Alarm	11,806	65
Witnessed Casualty	10,124	56
Witnessed SCUD Attack	9,743	54
Witnessed Actual Combat	6,746	37
Wounded in Combat	314	2

\* Percent of participants who answered Yes or No (excludes unknown).

## Physician-Elicited Symptoms

Table 3 summarizes the frequency distribution of positive responses to the Provider-Administered Symptom Questionnaire. The most frequently reported chief complaints were: fatigue (10%), joint pain (11%), headache (7%), and/or memory loss (4%). The percentages of patients reporting any of the major complaints included fatigue (47%), joint pain (49%),



headache (39%), memory loss (34%), sleep disturbance (32%), rash/dermatitis (31%), and/or difficulty concentrating (27%).

**Table 3. Symptom Frequency for CCEP Participants (N=18,075)**

<b>Symptoms Reported By Participants</b>	<b>Chief Complaint* (%)</b>	<b>Any Complaint (%)</b>
Joint Pain	11	49
Fatigue	10	47
Headache	7	39
Memory Loss	4	34
Sleep Disturbance	2	32
Rash/Dermatitis	7	31
Difficulty Concentrating	*	27
Depression	1	23
Muscle Pain	1	21
Diarrhea	2	18
Dyspnea	3	18
Abdominal Pain/Gastrointestinal	3	17
Hair Loss	*	12
Bleeding Gums	*	8
Weight Loss	*	7
Allergies	*	*
Back Pain	2	2
Chest Complaints	2	2
Cough	1	1
Dizziness	1	1
Nausea	*	*
Sinus	1	1
Mood Swings	1	1
Insomnia	*	*
Other Chief Complaint Categories Representing <1% of Population	7	7
Chief Complaints Not Categorized	3	3
People with No Chief Complaints	31	
People with No Chief or Any Complaints	10	

\* less than 1%

The distribution of dates of onset of symptoms reported by the CCEP participants is presented in Table 4. Among those reporting a known date of onset, the most common period of onset for all symptoms is the nine-month interval after the Gulf War. Between 23% and 31% of participants who recalled a date of onset for at least one of their symptoms remembered it starting during this period. However, it is noteworthy that for all symptoms, no date of onset was recalled/recorded by over half of all participants. Thus, for over half the symptoms reported, no date of onset can be ascertained. Lacking data collected in closer proximity to the date of onset, the effects of recall bias cannot be discounted, which makes the appropriate interpretation of these data difficult.

**Table 4. Frequency of Date of Onset by Symptom**

Symptoms Reported by Participants	Number Rept. Symptom	Number with Date of Onset	< Aug 1990 %	Aug 90 thru Feb 91 %	Mar 91 thru Dec 91 %	Jan 92 thru Dec 92 %	Jan 93 thru Dec 93 %	Jan 94 thru Dec 94 %	Jan 95 into Dec 95 %
Joint Pain	8,384	3,516	7	15	23	21	15	14	5
Fatigue	8,135	3,283	2	16	31	22	14	11	3
Headache	6,743	2,699	6	18	25	19	14	13	5
Memory Loss	5,960	2,385	2	15	27	23	16	14	3
Sleep Loss	5,887	2,405	4	20	30	19	12	12	3
Rash	5,124	2,230	5	21	29	18	10	11	5
Concentration	4,899	1,834	2	16	30	21	15	13	3
Depression	4,140	1,583	4	18	29	20	13	13	6
Muscle Pain	3,900	1,418	4	17	28	20	13	14	4
Diarrhea	3,304	1,237	4	24	30	16	9	11	6
Shortness of Breath	3,028	1,492	4	14	25	20	15	17	7
Abdominal Pain	3,007	1,167	5	19	24	19	12	14	7
Hair Loss	2,145	872	7	16	29	20	12	12	4
Bleeding Gums	1,500	559	5	16	25	20	15	14	5
Weight Loss	1,235	469	3	19	25	15	11	17	10

## CCEP Diagnoses

Table 5 presents the 23 ICD-9-CM diagnostic codes for primary diagnoses occurring with a frequency of 1% or higher. The healthy diagnosis includes those participants seeking consultation without complaint or sickness as well as those diagnosed as normal or healthy. The specific diagnoses span various categories including psychological conditions; symptoms, signs and ill-defined conditions; and the musculoskeletal, nervous, respiratory, digestive, skin, and circulatory systems. Other than healthy, the frequency of each diagnosis was relatively low, with the highest (tension headache) at 3.4%, and the second highest (fatigue, not specified as chronic) at 3.3%. Appendix C presents additional information on the diagnoses assigned.

**Table 5. Primary Diagnoses Occurring in Greater Than 1% of CCEP Participants (N=18,075)**

Primary Diagnosis ICD-9 CM Code	Number	Percent Of Total
Healthy (V65.5)*	1762	9.7
Tension Headache (307.81)	622	3.4
Fatigue, Not Specified as Chronic (780.71)	595	3.3
Depressive Disorder Not Elsewhere Classified (311.)	525	2.9
Prolonged Posttraumatic Stress Disorder (309.81)	501	2.8
Headache (784.0)	495	2.7
Migraine, Unspecified (346.9)	480	2.7
Pain in Joint Involving Multiple Sites (719.49)	437	2.4
Asthma, Unspecified (493.9)	401	2.2
Lumbago (724.2)	356	2.0
Pain in Joint Involving Lower Leg (719.46)	323	1.8
Other General Symptoms (780.9)	305	1.7
Irritable Colon (564.1)	291	1.6
Allergic Rhinitis, Cause Unspecified (477.9)	286	1.6
Osteoarthritis, Unspecified (715.9)	272	1.5
Malaise and Fatigue (780.7)	267	1.5
Other and Unspecified Sleep Apnea (780.57)	252	1.4
Gastroesophageal Reflux Disease (GERD) (530.81)	251	1.4
Major Depressive Disorder, Single Episode (296.2)	242	1.3
Contact Dermatitis and Other Eczema, Unspecified (692.9)	227	1.3
Other Insomnia (780.52)	210	1.2
Neurotic Depression (300.4)	196	1.1
Essential Hypertension (401.9)	193	1.1

\* This code includes those participants seeking consultation without complaint or sickness as well as those diagnosed as normal and/or healthy.

The frequency distribution by category of diagnoses assigned by the CCEP is presented in Table 6. The most prevalent primary diagnostic categories, accounting for 67.7% of the participants, were psychological conditions (18.4%); musculoskeletal and connective tissue diseases (18.3%); symptoms, signs, and ill-defined conditions (17.9%); respiratory diseases (6.8%); and digestive system diseases (6.3%). An additional 9.7% received a diagnosis of healthy. CCEP clinicians have generally relied upon the common medical practice of determining primary diagnosis based upon the severity of illness relative to the participant's chief complaint.

When both primary and secondary diagnoses were considered, the same general patterns were observed. The most common categories were musculoskeletal diseases (found in 47.2% of participants); symptoms, signs, and ill-defined conditions (43.1%); psychological conditions (36.0%); digestive system diseases (20.4%); skin and subcutaneous diseases (19.9%); respiratory diseases (17.5%); and nervous system diseases (17.8%).

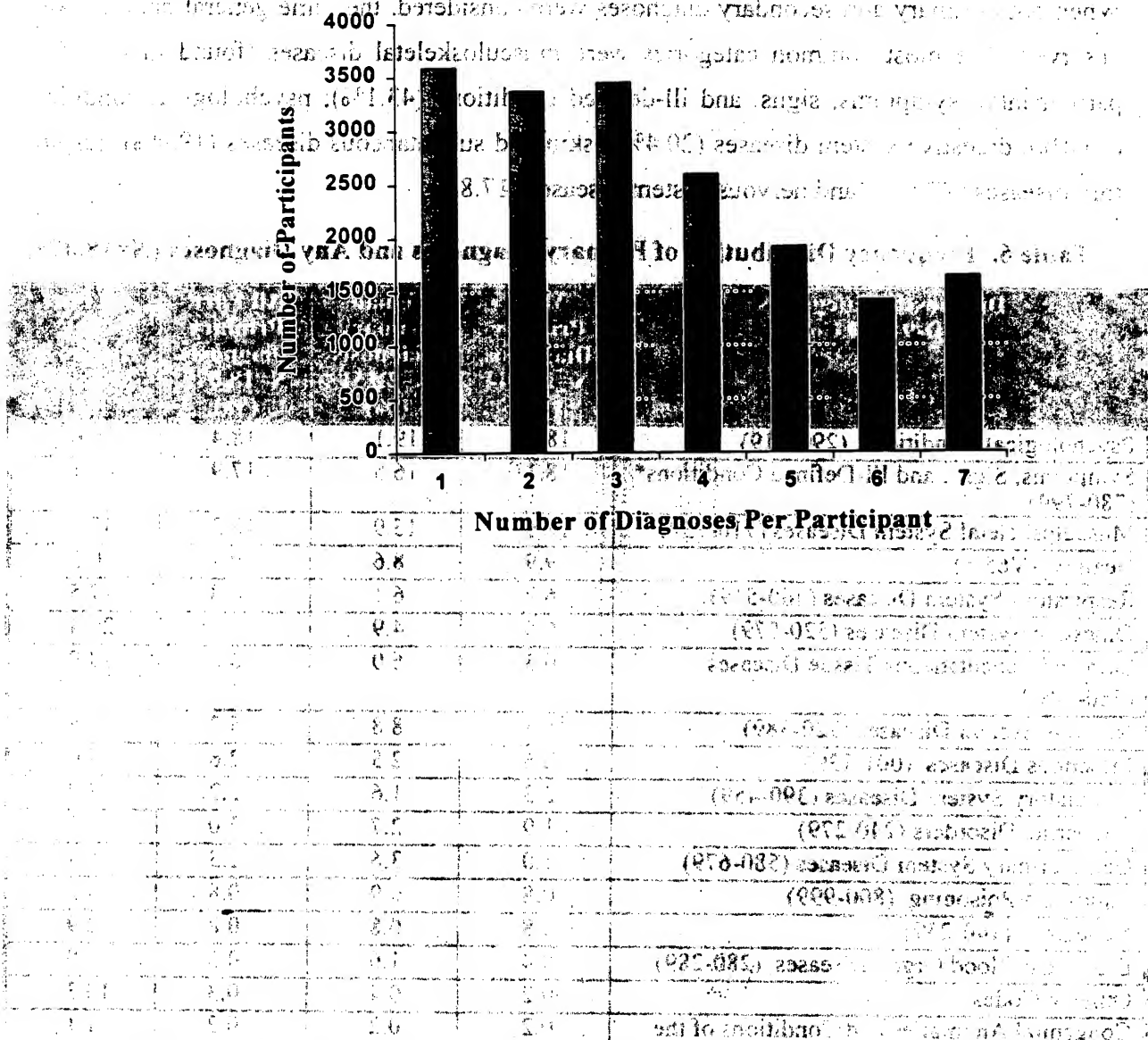
**Table 6. Frequency Distribution of Primary Diagnoses and Any Diagnoses (N=18,075)**

Diagnostic Categories (ICD-9-CM Code)	Male Primary Diagnosis N=15,944 (%)	Female Primary Diagnosis N=2,131 (%)	All Part. Primary Diagnosis N=18,075 (%)	All Part. Any Diagnosis N=18,075 (%)
Psychological Conditions (290-319)	18.3	19.1	18.4	36.0
Symptoms, Signs, and Ill-Defined Conditions* (780-799)	18.1	16.5	17.9	43.1
Musculoskeletal System Diseases (710-739)	18.6	15.9	18.3	47.2
Healthy (V65.5)	9.9	8.6	9.7	10.2
Respiratory System Diseases (460-519)	6.9	6.1	6.8	17.5
Digestive System Diseases (520-579)	6.5	4.9	6.3	20.4
Skin and Subcutaneous Tissue Diseases (680-709)	6.3	6.0	6.2	19.9
Nervous System Diseases (320-389)	5.3	8.8	5.7	17.8
Infectious Diseases (001-139)	2.6	2.5	2.6	9.0
Circulatory System Diseases (390-459)	2.3	1.6	2.2	8.0
Endocrine Disorders (240-279)	1.9	2.7	2.0	7.9
Genitourinary System Diseases (580-679)	1.0	3.6	1.3	5.4
Injury and Poisoning (800-999)	0.8	0.9	0.8	3.2
Neoplasm (140-239)	0.8	0.8	0.8	2.9
Blood and Blood Organ Diseases (280-289)	0.4	1.6	0.5	3.0
Other V Codes	0.2	0.4	0.3	10.3
Congenital Anomalies and Conditions of the Perinatal Period (740-779)	0.2	0.2	0.2	1.1

\* Includes conditions categorized according to ICD-9-CM nomenclature of cases for which no diagnosis is classifiable elsewhere no more specific diagnosis can be made; signs or symptoms that prove to be transient; cases in which a more precise diagnosis was not available for any other reason.

Up to seven diagnoses, including healthy, could be reported (one primary and up to six secondary). Among the participants, 19.9 percent had only 1 diagnosis, 18.7 percent had 2, the median was 3, the mean was 3.4, and 9.1 percent were given 7 diagnoses. This distribution is presented in Figure 2.

**Figure 2: Frequency Distribution of Diagnoses among 18,075 CCEP Participants**



The frequencies of primary diagnoses for four periods since initiation of the CCEP and until December 6, 1995 are presented in Table 7. Over time, there have been some changes in the frequency of diagnosis for most diagnostic categories. The proportion with a primary diagnosis of musculoskeletal/connective tissue disorder has steadily increased, from 16.1% in the first period, to 20% in the last. The proportion with psychological conditions was stable for the first two periods, then declined for the third and was stable through the fourth. The proportion with ill-defined conditions has steadily decreased, from 20.9% in the first period, to 15.2% in the fourth. For other diagnostic groupings, there were no patterns evident over time, or the numbers of diagnoses were too few for meaningful interpretation.

**Table 7. Frequency of Primary Diagnoses Over Time (N=18,075)**

Diagnostic Categories	Jun 94 thru Nov 94 N=3931 (%)	Dec 94 thru Feb 95 N=1782 (%)	Mar 95 thru Jun 95 N=8723 (%)	Jul 95 into Dec 95 N=3639 (%)	Jun 94 into Dec 95 N=18075 (%)
Psychological Conditions	19.9	20.0	17.6	17.6	18.4
Musculoskeletal Diseases	16.1	18.2	18.6	20.0	18.3
Symptoms, Signs, and Ill-Defined Conditions*	20.9	18.3	17.6	15.2	17.9
Healthy (V65.5)†	8.0	10.2	10.2	10.5	9.7
Respiratory System Diseases	6.4	5.8	7.3	6.5	6.8
Digestive System Diseases	6.8	6.3	6.0	6.3	6.3
Skin and Subcutaneous Tissue Diseases	4.9	6.0	6.8	6.5	6.2
Nervous System Diseases	6.5	5.0	5.3	6.2	5.7
Infectious Diseases	2.5	2.7	2.5	2.9	2.6
Circulatory System Diseases	2.1	1.8	2.2	2.5	2.2
Endocrine Disorders	2.0	2.1	1.9	2.3	2.0
Genitourinary Diseases	1.3	1.4	1.4	1.1	1.3
Neoplasm	1.0	0.6	0.8	0.7	0.8
Injury and Poisoning	0.5	0.8	0.9	0.9	0.8
Blood and Blood Organ Diseases	0.6	0.5	0.5	0.6	0.5
Other V Codes	0.3	0.2	0.2	0.3	0.2
Congenital Anomalies and Conditions of the Perinatal Period	0.2	0.3	0.2	0.3	0.2

\* Includes conditions categorized according to ICD-9 nomenclature of cases for which no diagnosis is classifiable elsewhere; no more specific diagnosis can be made; signs or symptoms that prove to be transient; and cases in which a more precise diagnosis was not available for any other reason.

† This code includes those participants seeking consultation without complaint or sickness as well as those diagnosed as normal and/or healthy.

## Examination of the Top Three Primary Diagnostic Categories

Psychological conditions; symptoms, signs, and other ill-defined conditions; and musculoskeletal diseases diagnostic categories account for over 50% of all primary diagnoses among the 18,075 participants covered by this report. The distribution of these diagnoses is presented in greater detail in Table 8, Table 9, and Table 10.

About eighteen percent (18.4%) of CCEP patients had a primary diagnosis of a psychological condition. The most frequent diagnoses of this group are summarized in Table 8. Tension headache, depression, anxiety disorders, adjustment reactions, and somatoform disorders were the most frequently recorded psychological diagnoses. It is important to realize that the common diagnosis of tension headache is included in this category.

**Table 8. Number and Percent of Primary Diagnoses of Psychological Conditions (ICD-9-CM Codes 290-319) (N=3,321)**

Specific Diagnoses (ICD-9-CM Code)	Number	Percent
Tension Headache (307.81)	622	18.7
Depressive Disorder, NEC (311)	525	15.8
Prolonged Posttraumatic Stress Disorder (309.81)	501	15.1
Major Depressive Disorder (296.2)	289	8.7
Adjustment Reaction (309)	231	7.0
Neurotic Depression (300.4)	196	5.9
Somatization Disorder (300.81)	114	3.4
Anxiety State (300.00)	92	2.8
Alcohol Dependence and Abuse (303 and 305)	52	1.6
Sleep Disorder (307.4)	91	2.7
Unspecified Psychophysiological Malfunction (306.9)	49	1.5
Tobacco Use Disorder (305.1)	44	1.3
Unspecified Acute Reaction to Stress (308.9)	37	1.1
Panic State (300.01)	33	1.0
Organic Brain Syndrome	100	3.0
Generalized Anxiety Disorder (300.02)	26	0.8
Other	319	9.6
<b>Total</b>	<b>3,321</b>	<b>100.0</b>

Almost eighteen percent (17.9%) of participants had a primary diagnosis of symptoms, signs, and ill-defined conditions (Table 9). Most diagnoses in this category involved conditions such as malaise and fatigue, sleep disturbance, and/or headache.

**Table 9. Number and Percent of Primary Diagnoses of Symptoms, Signs, and Ill-Defined Conditions (ICD-9-CM Codes 780-799) (N=3,239)**

<b>Specific Diagnoses (ICD-9-CM Code)</b>	<b>Number</b>	<b>Percent</b>
Malaise and Fatigue (780.7)	862	26.6
Sleep Disturbances (780.5)	574	17.7
Headache (784.0)	495	15.3
Other General Symptoms (780.9)*	305	9.4
Dyspnea and Painful Respirations (786.09, 786.52)	181	5.6
Rash (782.0, 782.1)	159	4.9
Syncope (780.2), Seizures (780.3) & Vertigo (780.4)	94	2.9
Other Chest Pain (786.50, 786.59)	70	2.2
Abdominal Pain (789.0)	43	1.3
Nonspecific Reaction to Tuberculin Test (795.5)	44	1.4
Cough (786.2)	36	1.1
Other	376	11.6
<b>Total</b>	<b>3239</b>	<b>100.0</b>

\* The category "Other General Symptoms" (ICD-9-CM code 780.9) consists almost exclusively of reported problems with memory (137 out of 144).



About eighteen percent (18.3%) of CCEP patients had a primary diagnoses in the category of musculoskeletal and connective tissue conditions (Table 10). Pain in joints, osteoarthritis, and backache accounted for over 50% of all diagnoses in this group.

**Table 10. Number and Percent of Primary Diagnoses of Musculoskeletal Conditions (ICD-9-CM Categories 710-739) (N=3,307)**

<b>Specific Diagnoses (ICD-9-CM Code)</b>	<b>Number</b>	<b>Percent</b>
Pain in Joint (719.4)	992	30.0
Lumbago and Backache, Unspecified (724.2 and 724.5)	411	12.4
Osteoarthritis, Unspecified (715.89 - 715.99)	405	12.2
All Other Diagnoses Related to the Spine (720-724.9 except the above)	269	8.1
Myalgias and Myositis, Unspecified (729.1)	228	6.9
Diseases and Disorders of Shoulder Region (726.10, 726.2)	118	3.6
Other Specified Disorders of Lower Leg Joint (mostly patello-femoral syndrome) (719.86)	109	3.3
Osteoarthritis, Localized (715.1-715.39)	56	1.7
Chondromalacia of Patella (717.7)	37	1.1
Tietze's Disease (733.6)	33	1.0
Unspecified Arthropathy (716)	32	1.0
Other and Unspecified Disorders of Soft Tissue (729.9)	29	0.9
Rheumatoid Arthritis (714)	26	0.8
Lateral Epicondylitis (726.32)	24	0.7
Pain in Limb (729.5)	21	0.6
Flat Foot (734)	19	0.6
Enthesopathy of Hip Region (726.5)	19	0.6
Enthesopathy of Unspecified Site (726.90)	17	0.5
Plantar Fascial Fibromatosis	17	0.5
Other	445	13.5
<b>Total</b>	<b>3307</b>	<b>100.0</b>

The frequency of the most prevalent primary diagnostic categories for the five age groups is shown in Table 11. The frequency of psychological conditions shows some decrease with increasing age. This trend is also seen for the healthy ICD-9-CM diagnosis. The musculoskeletal conditions ICD-9-CM category seems to show increases with increasing age. The four most frequent diagnoses represent from 63% to 65% of the diagnoses in each age group.

**Table 11. Frequency of Most Prevalent Primary Diagnoses by Age Group (N=18,075)**

Diagnostic Category	17 - 20 N=1,717 (%)	21 - 25 N=4,141 (%)	26 - 30 N=4,141 (%)	31 - 35 N=4,031 (%)	36 - 65 N=3,938 (%)	Other*/ No Data N=114 (%)
Psychological Conditions	21	20	18	18	17	25
Symptoms, Signs and Ill-Defined Conditions	16	18	18	18	19	18
Musculoskeletal System Diseases	15	16	18	20	20	18
Healthy	13	11	11	9	7	7
Other Medical Conditions	35	35	35	35	37	34

\* Includes ages under 17 and over 65.

Table 12 shows that the four most frequent primary diagnostic categories represent 65.1% of males and 60.5% of females. The distribution of diagnosis is similar in men and women.

**Table 12. Frequency of Most Prevalent Primary Diagnoses by Sex (N=18,067\*)**

Diagnostic Category	Male N=15,937 (%)	Female N=2,130 (%)
Psychological Conditions	18.3	19.1
Symptoms, Signs and Ill-Defined Conditions	18.1	16.6
Musculoskeletal System Diseases	18.6	15.9
Healthy	10.1	8.9
Other Medical Conditions	34.9	39.5

\* No data is available for 8 participants.

Table 13 shows the frequency of the most prevalent primary diagnostic categories for each military branch. The four most prevalent primary diagnostic categories represent 66.1% of CCEP participants from the Army, 59.5% of Navy participants, 57.7% of Air Force and 58.1% of Marines. Distribution of diagnoses are similar among the services.

**Table 13. Frequency of Most Prevalent Primary Diagnoses by Military Branch (N=18,075)**

Diagnostic Category	Army N=14,588 (%)	Navy N=750 (%)	Air Force N=1,714 (%)	Marine Corps N=781 (%)	Other/ No Data N=242 (%)
Psychological Conditions	18.9	18.0	15.1	16.1	16.1
Symptoms, Signs & Ill-Defined Conditions	17.7	19.3	19.9	17.4	14.5
Musculoskeletal System Diseases	19.0	13.9	15.0	16.5	16.5
Healthy	10.4	8.3	7.6	8.1	11.6
Other Medical Conditions	33.9	40.5	42.3	41.9	41.3

Neoplasms were a primary diagnosis in almost 1% of the participants. A primary diagnosis of malignant disease (Table 14) was found in 52 (0.3 %) of in-theater CCEP participants. The most frequently diagnosed malignant neoplasms were skin cancers and lymphomas.

**Table 14. 52 Cases of Malignant Neoplasms by Sex in CCEP Participants (N=18,075)**

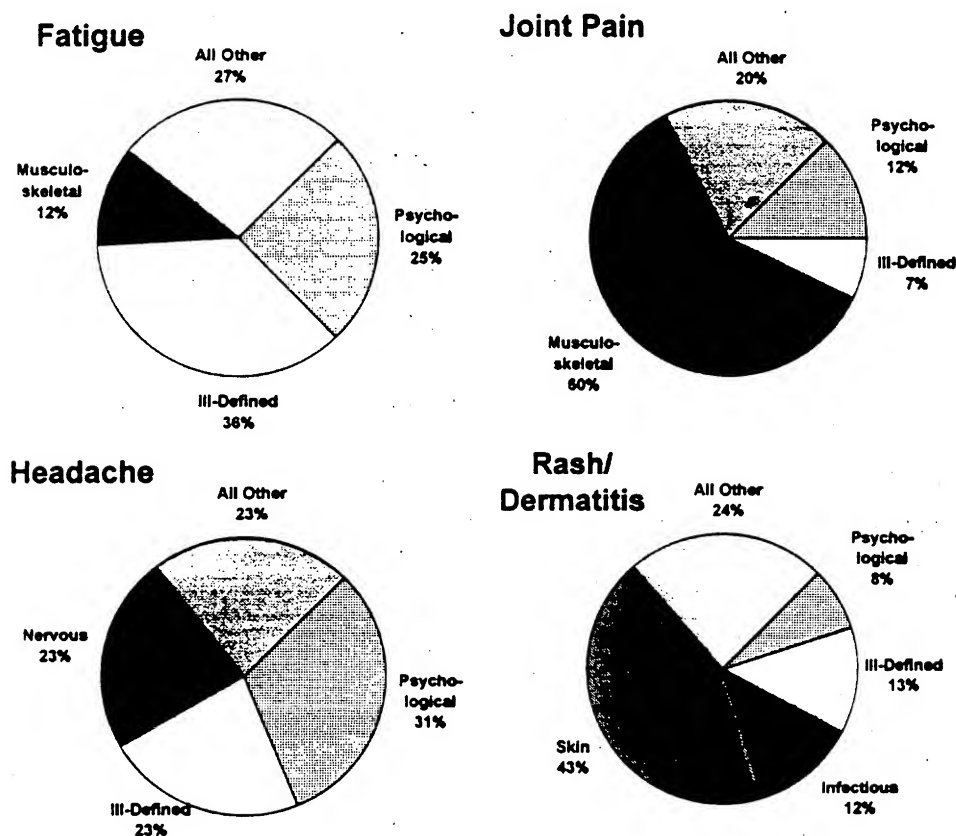
Category	Number Of Diagnoses	
	Male	Female
Skin	9	---
Basal Cell	5	---
Malignant Melanoma	3	---
Squamous Cell	1	---
Hodgkin's Disease	8	---
Non-Hodgkin's Lymphoma	4	1
Brain	5	---
Thyroid	1	1
Prostate	1	---
Testicular and Other Male Gonadal	4	---
Chronic Myelogenous Leukemia	4	---
Chronic Lymphocytic Leukemia	2	---
Acute Myelogenous Leukemia	---	1
Colon	1	---
Breast	---	2
Cervix Uteri	---	1
Ovary	---	1
Stomach	---	1
Lung	3	---
Bladder	1	---
Kidney	1	---
<b>Total</b>	<b>44</b>	<b>8</b>

### **Distribution of Primary Diagnosis Based upon Chief Complaint**

The primary diagnoses associated with the leading chief complaints were examined, and they are presented in Figure 3. Among those participants with a chief complaint of fatigue, the most common diagnostic group was symptoms, signs, and ill-defined conditions; followed by psychological conditions; and musculoskeletal system and connective tissue diseases. Within the diagnostic group of symptoms, signs, and ill-defined conditions, 49% had a primary ICD-9 diagnosis of malaise and fatigue (780.7).

Nearly two-thirds of participants with a chief complaint of joint pain received a primary diagnosis in the musculoskeletal system and connective tissue disease category; followed by symptoms, signs, and ill-defined conditions; and psychological conditions. All other diagnoses accounted for 20% of the total. Among those with a primary diagnosis in the “musculoskeletal system and connective tissue disease” category, 20% had a diagnosis involving multiple sites, and another 20% had a diagnosis involving unspecified sites. There was no apparent clustering of diagnosis by anatomic site.

**Figure 3. Distribution of Primary Diagnoses Based upon Chief Complaint**



The most common category for those with a chief complaint of headache was psychological conditions (31%), followed by symptoms, signs, and ill-defined conditions (23%), and nervous system and sense organs diseases (23%). Among those with a diagnosis within the category of

psychological conditions diagnosis, 67% had a specific diagnosis of tension headache (307.81); among those with a diagnosis within the category symptoms, signs, and ill-defined conditions, 73% had a diagnosis of headache (784.0); and among those with a diagnosis in the nervous system and sense organs category, 77% had a diagnosis of migraine headache (346.0 to 346.9). Thus, among those with a chief complaint of headache, 55% were assigned a primary diagnosis of headache.

Over 40% of CCEP participants with a chief complaint of rash/dermatitis received a diagnosis in the skin and subcutaneous tissue group, followed by symptoms, signs, and ill-defined conditions (13% ), followed by infectious and parasitic diseases (12%), psychological conditions (8%), and all other diagnostic groups (24%). Within the skin and subcutaneous tissue group, 27% had a diagnosis of unspecified contact dermatitis; within the symptoms, signs, and ill-defined conditions 50% had a diagnosis of rash.

## Frequency of Secondary Diagnoses Given a Primary Diagnosis

Table 15 provides the secondary diagnostic groups for participants with a primary diagnosis of psychological condition. The most common second diagnosis for these is also psychological, followed by musculoskeletal. For subsequent diagnoses, psychological, musculoskeletal, and ill-defined conditions predominate. Among those with a primary diagnosis of ill-defined conditions, the most common secondary diagnoses are ill-defined, musculoskeletal, and psychological conditions (Table 16). For those with a primary diagnosis of musculoskeletal, the most prevalent second diagnosis is musculoskeletal, followed by ill-defined conditions, and psychological (Table 17). Those with a primary diagnosis of respiratory were most likely to have a second diagnosis also of respiratory, followed by musculoskeletal, and, symptoms, signs and ill-defined (Table 18).

The patterns of secondary diagnoses change only slightly from diagnosis two through diagnosis seven. This is true for all secondary diagnoses regardless of the primary diagnostic category.

**Table 15. The Proportion of Secondary Diagnoses Given a Primary Diagnosis of Psychological (N=3,321)**

Secondary Diagnosis	Infectious Disease	Neoplasm	Endocrine System	Blood & Blood Disorders	Psychological	Nervous System	Circulatory System	Respiratory System	Digestive System	Genitourinary	Skin & Subcutaneous	Musculoskeletal	Congenital	Ill-Defined	Injury & Poisoning	Healthy
First (%)	2	0	2	1	28	6	2	4	8	1	5	18	0	15	1	7
Second (%)	4	1	3	1	15	7	2	6	9	2	7	22	0	15	1	5
Third (%)	4	1	6	1	10	6	4	9	6	2	8	22	0	16	2	4
Fourth (%)	4	1	2	1	9	7	3	7	9	2	8	22	1	17	2	6
Fifth (%)	3	1	4	1	10	7	4	6	10	2	8	20	1	17	1	5
Sixth (%)	5	1	3	0	11	9	4	6	11	4	7	19	0	15	1	5

**Table 16. The Proportion of Secondary Diagnoses Given a Primary Diagnosis of Symptoms, Signs, and Ill-Defined Conditions (N=3,239)**

Secondary Diagnosis	Infectious Disease	Neoplasm	Endocrine System	Blood & Blood Disorders	Psychological	Nervous System	Circulatory System	Respiratory System	Digestive System	Genitourinary	Skin & Subcutaneous	Musculoskeletal	Congenital	Ill-Defined	Injury & Poisoning	Healthy
First (%)	2	1	2	1	13	5	2	6	8	2	5	21	0	27	1	5
Second (%)	2	1	2	1	11	4	2	6	7	2	7	22	6	27	1	4
Third (%)	2	1	3	1	10	6	2	6	8	2	8	20	1	25	1	5
Fourth (%)	3	1	4	2	12	6	3	6	10	2	7	17	0	24	1	4
Fifth (%)	3	1	4	1	10	7	4	6	9	2	6	18	6	23	2	3
Sixth (%)	3	1	4	1	12	6	4	7	7	3	8	14	1	23	2	5

**Table 17. The Proportion of Secondary Diagnoses Given a Primary Diagnosis of Musculoskeletal (N=3,307)**

Secondary Diagnosis	Infectious Disease	Neoplasm	Endocrine System	Blood & Blood Disorders	Psychological	Nervous System	Circulatory System	Respiratory System	Digestive System	Genitourinary	Skin & Subcutaneous	Musculoskeletal	Congenital	Ill-Defined	Injury & Poisoning	Healthy
First (%)	3	1	2	1	12	6	2	5	5	1	6	27	0	20	2	7
Second (%)	3	1	2	1	14	6	2	5	7	2	8	19	0	24	1	4
Third (%)	3	1	3	6	15	6	3	6	9	2	8	13	1	24	1	4
Fourth (%)	4	1	3	1	13	9	3	6	9	2	7	15	0	22	1	5
Fifth (%)	4	1	4	1	14	7	4	7	11	2	6	12	1	21	1	5
Sixth (%)	4	2	5	2	13	7	6	5	8	2	5	13	0	23	1	6

**Table 18. The Proportion of Secondary Diagnoses Given a Primary Diagnosis of Respiratory (N=1,229)**

Secondary Diagnosis	Infectious Disease	Neoplasm	Endocrine System	Blood & Blood Disorders	Psychological	Nervous System	Circulatory System	Respiratory System	Digestive System	Genitourinary	Skin & Subcutaneous	Musculoskeletal	Congenital	Ill-Defined	Injury & Poisoning	Healthy
First (%)	3	1	2	1	10	6	3	19	6	2	7	17	0	16	1	6
Second (%)	3	1	3	1	14	7	3	6	7	1	6	21	1	18	1	6
Third (%)	4	1	6	1	10	6	4	9	6	2	6	22	0	16	2	4
Fourth (%)	4	1	5	1	10	7	2	9	6	3	10	17	1	18	2	5
Fifth (%)	3	2	3	1	13	6	5	7	9	2	14	14	0	15	1	6
Sixth (%)	3	1	0	1	12	6	3	5	11	5	5	20	1	21	6	8



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## Unit Identification Codes (UICs)

The 687,851 personnel who deployed to the Persian Gulf War, for whom unit identification data are available, were assigned to military units designated by 13,450 unique UICs. The number of deployed personnel assigned to a single UIC varied from one person to several thousand (e.g., an aircraft carrier crew). Additionally, the Air Force used a limited number of large “administrative” UICs (for example one UIC had 20,978 personnel assigned). Of the 18,075 in-theater CCEP participants with completed evaluations, 16,917 had UIC information available. These CCEP participants were assigned to 4,056 different UICs, to which 537,637 service members (77% of the total force) were assigned. The overall rate of CCEP participation for these 4,056 UICs was 3.1% (16,917/537,637). There were no CCEP participants with completed evaluations from at least 9,394 UICs representing about 150,214 service members.

The number of CCEP participants per UIC was examined. The descriptive characteristics of the units are presented in Table 19. After excluding UICs with fewer than 40 members in the Gulf theater and UICs with 1,000 or more members from the analysis, the distribution of CCEP participant rates was stratified into quintiles. Because the quintile of units with highest participation had substantially more members in the CCEP ( $n=5074$ ) than the lowest quintile ( $n=1043$ ), the second lowest quintile ( $n=1331$ ) was combined with the first. Thus, the comparisons are between the CCEP members in the highest quintile to the combined populations of the two lowest CCEP participation rate quintiles.

**Table 19. Descriptive Characteristics of Units in the Lowest and Highest CCEP Participation Groups**

<b>Descriptor</b>	<b>Levels of CCEP Participation</b>	
	<b>Lowest 40%</b>	<b>Highest 20%</b>
<b>Number of UICs</b>	1032	517
<b>Population</b>		
<b>Total Number of Individuals</b>	2374	5074
<b>Unit Size</b>		
Minimum	40	40
Maximum	993	466
Median	139.5	107
Mean	206.4	118
<b>CCEP Participants per Unit</b>		
Minimum	1	3
Maximum	15	37
Median	2	9
Mean	2.3	9.8
<b>Percentage of Unit Members Who Are CCEP Participants</b>		
Minimum	0.12	6.3
Maximum	2.7	26.2
Median	1.4	7.8
Mean	1.4	8.6

The self-reported exposures for the groups are presented in Table 20, along with those for all CCEP members. Based on data from participants who responded with either a yes or no, there are few differences among those in the highest and lowest participation groups.

**Table 20. Self-Reported Exposure History for Members of Units with Lowest and Highest CCEP Participation Rates\***

Exposure As Recalled By Participants	Lowest 40% N=2374	Highest 20% N=5074	CCEP Pop. N=18,075
Cigarette Smoke (Passive)*	92	91	90.9
Diesel/Other Fuels	92	95	93.4
Pyridostigmine Bromide	85	92	85.7
Oil Fire Smoke	84	85	81.0
Tent/Heater Fumes	61	83	74.0
Personal Pesticide Use	74	75	74.1
Ate Non-U.S. Foods	70	67	69.4
Had Anthrax Immunization	81	85	81.6
Solvent	76	76	75.9
Chemical Agent Resistant Coating (CARC)	67	74	69.8
Other Paint	73	71	71.0
Microwaves	51	45	48.8
Bathed in/Drank Non-U.S. Water	42	31	36.7
Had Botulism Immunization	60	67	61.8
Took Oral Medicine to Prevent Malaria	66	78	70.3
Ate Contaminated Food	52	50	46.8
Bathed in Contaminated Water	46	44	41.3
Depleted Uranium	32	37	35.3
Nerve Gas/Nerve Agents	23	20	19.7
Mustard Gas/Blistering Agents	8	6	5.6
Chemical Alarm	70	66	65.3
Witnessed Casualty	58	62	56.0
SCUD Attack	51	57	53.9
Witnessed Actual Combat	41	42	37.3
Wounded in Combat	2	2	1.7

\* Exposures expressed as percent of participants who answered Yes or No (excludes unknowns).

The symptoms reported by the participants answering yes or no is given in Table 21. There are few differences between the populations in the higher and lower quintile UICs.

**Table 21. Symptom Frequency for Members of Units with Lowest and Highest CCEP Participation Rates**

Symptom As Elicited By Physician	Lowest 40% N=2374 (%)	Highest 20% N=5074 (%)
Fatigue	46	42
Abdominal Pain	17	15
Diarrhea	19	17
Shortness of Breath	18	16
Difficulty Concentrating	27	25
Hair Loss	11	12
Headaches	37	36
Joint Pain	44	46
Memory Loss	34	31
Muscle Pain	21	20
Rash	28	26
Sleep Disturbance	33	31
Weight Loss	8	6
Bleeding Gums	8	8
Depression	23	22

Table 22 presents the primary diagnoses given to the participants. There were no major differences in the distribution of diagnoses between the two participant categories.

**Table 22. Frequency Distribution Comparison of Primary Diagnoses for Members of Units with Lowest and Highest CCEP Participation Rates**

<b>Primary Diagnostic Categories (ICD-9-CM Code)</b>	<b>Lowest 40% N=2374 (%)</b>	<b>Highest 20% N=5074 (%)</b>
Psychological Conditions (290-319)	19	19
Musculoskeletal Diseases (710-739)	16	19
Symptoms, Signs and Ill-Defined (780-799)	18	18
Healthy (V65.5)	8	11
Digestive System (520-579)	7	6
Respiratory System (460-519)	7	7
Skin and Subcutaneous (680-709)	6	6
Nervous System and Sensory (320-389)	7	5
Infectious Diseases (001-0139)	3	2
Circulatory System (390-459)	2	2
Endocrine/Nutritional (240-279)	2	2
Genitourinary System (580-679)	1	1
Neoplasms (140-239)	1	1
Injury and Poisoning (800-999)	1	1
Blood and Blood-Forming (280-289)	0	1
Congenital Anomalies (740-779)	0	0

The proportion of all diagnoses given is shown in Table 23. There were few substantial differences in the diagnostic categories reported between high and low participation UICs.

**Table 23. Frequency Distribution of Any Diagnoses for Members of Units with Lowest and Highest CCEP Participation Rates**

Any Diagnosis	Lowest 40% N=2374 (%)	Highest 20% N=5074 (%)
Psychological Conditions	37	36
Musculoskeletal System Diseases	44	49
Symptoms, Signs and Ill-Defined Conditions	41	43
Respiratory System Diseases	18	17
Digestive System Diseases	23	19
Skin and Subcutaneous Tissue Diseases	19	20
Nervous System Diseases	20	17
Infectious Diseases	9	8
Circulation System Diseases	8	8
Endocrine Disorders	9	7
Genitourinary System Diseases	6	5
Neoplasms	3	3
Injury and Poisoning	3	4
Blood and Blood Organ Diseases	9	7
Congenital Disorders	1	1

## Disability Indicators

### Self-Reported Lost Workdays

As an approximation of the severity of morbidity or acute disability, CCEP participants were asked the question, "How many workdays were lost due to illness (last 90 days)?" Approximately 20% of all participants reported missing any workdays. The extent to which the CCEP disability experience reflects the overall disability of Persian Gulf veterans is limited by the fact that many Persian Gulf War veterans are no longer on active duty.

Table 24 shows that the percent of participants reporting "1-90" did not differ greatly between ICD-9-CM categories (range: 10% - 26%). Among the ICD-9-CM code groups, the mean number of workdays lost ranged from one to nine. Neoplasms represent the disease category with the greatest mean number of missed workdays at 9 for the 20 percent reporting any lost workdays. For those reporting lost workdays, the median number of workdays lost ranged from four to six for most diagnoses, with the exception of neoplasms, having a median of 15, and respiratory conditions, having a median of 8.5.

**Table 24. Workdays Lost to Illness in Past 90 Days by Primary Diagnosis (N=18,075)**

Primary Diagnosis	Number of Participants	Total Days Lost	Mean Days Lost	Participants Reporting 1-90 Days Lost		
				%	Mean	Median
Infectious Diseases	470	1,120	2.4	19.2	12.4	6.0
Neoplasms	144	1,301	9.0	16.4	34.2	15.0
Endocrine Disorders	461	1,045	2.3	22.1	10.2	5.0
Psychological Conditions	3,321	12,211	3.7	24.6	14.9	6.0
Nervous System Diseases	1,029	3,533	3.4	26.0	13.2	5.0
Circulatory System Diseases	396	956	2.4	20.7	11.7	5.0
Respiratory System Diseases	1,229	2,733	2.2	22.4	9.9	8.5
Digestive System Diseases	1,131	2,822	2.5	25.6	9.7	4.0
Genitourinary System Diseases	236	632	2.7	25.8	10.4	5.0
Skin and Subcutaneous Tissue Diseases	1,125	1,559	1.4	16.0	8.7	4.0
Musculoskeletal System Diseases	3,307	6,757	2.0	18.1	11.3	5.0
Congenital Anomalies and Perinatal Conditions*	41	53	1.3	14.6	8.8	5.0
Symptoms, Signs and Other Ill-Defined Conditions	3,239	7,169	2.2	19.0	11.6	5.0
Injury and Poisoning	141	435	3.1	21.3	14.5	6.0
E and V Codes ("Healthy")	1,805	1,445	0.8	10.2	9.8	4.0
<b>Total</b>	<b>18,075</b>	<b>43,771</b>	<b>2.4</b>	<b>20.1</b>	<b>12.0</b>	<b>5.0</b>

\* Includes one case of angiomata of undetermined etiology (25 days), one case of bicuspid aortic valve insufficiency (2 days), one case of dysplastic hip disease (10 days), one case of congenital bilateral hip dysplasia (10 days), one case of spondylolisthesis (1 day) and one case of polycystic kidney disorder (5 days).

## DoD's Physical Evaluation Board Experience

Physical Evaluation Boards (PEBs) are medical boards convened to evaluate whether or not a service member's diagnosed condition precludes their retention in the Armed Services. The findings of PEBs were reviewed as another indicator of severity of morbidity and disability. Comparisons of the PEB results for DoD CCEP participants and PGW veterans who are not CCEP participants are shown in Table 25. Of those CCEP participants who met PEBs 56% received medical separations. Seventy-seven percent of the non-CCEP PGW veterans who were referred to PEBs were medically separated.

**Table 25. Comparison of PEB Experience for Non-CCEP PGW Veterans and CCEP Participants**

	CCEP In-Theater Participants	Non-CCEP PGW Veterans
Population	N=17,833*	N=678,864*
Met PEB (%)	988 (5.5%)	13,117 (1.9%)
Medical Separation	549 (3.1%)	9,550 (1.4%)

\* Population excludes Coast Guard in PGW.

There are 93,944 service members who have undergone PEBs since August 1, 1990, of whom 14,105 were Gulf War veterans. These data reflect only the DoD's disability experience and do not contain the results of non-DoD disability proceedings. Of those service members meeting PEBs since August 1990, 14.3 percent were PGW veterans. Eight percent of PGW veterans meeting PEBs were CCEP participants.



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## Diagnoses Among Family Members

### Diagnoses Among Spouses

The frequency of primary and any diagnoses for spouses of PGW veterans is provided in Table 26. The distribution of diagnoses of military participants compared to spouses is very similar.

**Table 26. Distribution of Primary Diagnoses and Any Diagnosis for Spouses (N=332)**

Diagnostic Categories	Spouses	
	Primary Diagnosis (%)	All Diagnoses (%)
Psychological Conditions	20.8	39.5
Musculoskeletal System Diseases	9.9	33.7
Symptoms, Signs and Ill-Defined Conditions	14.5	42.2
Healthy	9.9	5.4*
Respiratory System Diseases	4.2	15.7
Digestive System Diseases	4.8	23.5
Skin and Subcutaneous Tissue Diseases	7.8	22.6
Nervous System Diseases	8.7	18.1
Infectious Diseases	1.5	7.2
Circulatory System Diseases	1.8	7.2
Endocrine Disorders	5.1	12.3
Genitourinary System Diseases	8.4	17.8
Neoplasms	0.6	3.6
Injury and Poisoning	0.3	2.4
Blood and Blood Organ Diseases	0.9	4.5
Congenital Abnormalities and Conditions of the Prenatal Period	0.3	1.5

\* Includes spouses having a healthy primary and no secondary diagnoses.

## Diagnoses Among Children

Table 27 presents the number of children who are CCEP participants within each primary diagnostic category. The most common diagnosis is healthy, followed by congenital abnormalities, skin conditions, other, and respiratory conditions.

**Table 27. Frequency Distribution of Primary Diagnosis for CCEP Children of Persian Gulf War Veterans (N=191)**

Diagnosis	Number
Healthy (Normal Exam)	72
Congenital Anomalies*	35
Dermatitis, Eczema, Folliculitis, Acne	14
Other	11
Upper Respiratory Infections	9
Asthma, Reactive Airway Disease	6
Psychosis, Depression, Obsessive/Compulsive Disorder	6
Otitis Media	6
Attention Deficit/Hyperactivity	5
Seizures	5
Developmental Delay	4
Gastroesophageal Reflux	4
Nephritis, Vesicoureteral Reflux, Hydrocele	4
Dermoid Cysts, Hemangiomas	3
Rash	2
Anemia	1
Choroid Plexus Carcinoma	1
Chronic Pneumonia	1
Insomnia	1
Tinea Capitis	1
<b>Total</b>	<b>191</b>

- \* Specific diagnoses include: congenital heart disease (3); cleft lip or palate (5); chromosomal abnormalities (4); hydrocephalus (5); minor congenital defects (11), including duplicated toe and pectus excavatum; and others (7).

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## Self-Reported Reproductive Events and Conditions

Table 28 displays the proportion of participants self-reporting reproductive events and conditions in the periods three years prior to and three years after ODS/S. There were 8,819 participants who provided information on both the pre- and postwar periods. With the exception of conceptions, which decreased 5%, there were increases in the frequencies of all other reproductive events and conditions. The self-selection of participants into the CCEP and their self-reporting of reproductive events and conditions makes interpretation of these data problematic. This issue is described further in the Discussion section.

**Table 28. Frequency of Self-Reported Reproductive-Events and Conditions (N=8,819)**

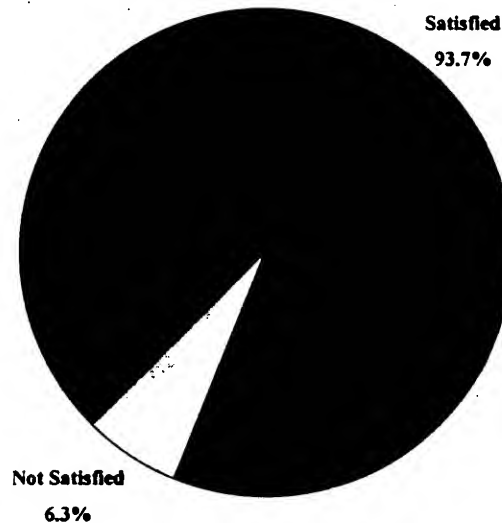
Frequency Of Self-Reported Events And Conditions		
Event/Condition	Proportion Reporting Events	
	3 Years Prior	3 Years Post
Any Children Conceived	31.4	29.9
Infertility	6.2	13.7
Any Miscarriages	5.3	7.8
Any Stillbirths	0.8	1.0
Any Infant Deaths	0.3	0.5
Any Children with Birth Defects	0.7	2.6

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## Participants' Satisfaction

Beginning in January 1995, CCEP participants were asked at the completion of their examination to indicate their opinion of the care they received by answering the question "Were you satisfied with the care you received in the program?" Responses were available for 68% of in-theater participants. Figure 4 shows an overall satisfaction rate of 93.7% for the 12,283 CCEP participants who answered the question regarding satisfaction.

**Figure 4. Participants' Satisfaction (N=12,283)**



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## Comparison of Diagnoses in CCEP to NAMCS

The distributions of primary diagnostic categories for CCEP participants and for subjects from the National Ambulatory Medical Care Survey (NAMCS) are presented in Table 29 for persons aged 20-40 years. Because there are basic underlying differences between the CCEP and the NAMCS populations, caution must be exercised in interpreting the data. CCEP participants generally have health complaints or health concerns sufficient to cause them to seek evaluation. Data on persons in the NAMCS population represent individuals seeking medical attention for unknown reasons, which could include concerns over specific conditions as well as routine examinations in the absence of any adverse condition.

Compared to the NAMCS population, men in the CCEP population were two to five times more likely to receive a diagnosis in the categories of psychological conditions; signs, symptoms, and ill-defined conditions; and musculoskeletal conditions. The proportion with a diagnosis of healthy did not differ substantially, and CCEP participants were less likely to receive a diagnosis in the respiratory, nervous, infectious disease, and skin categories. For the other categories, there were few differences between the CCEP and NAMCS populations, or the proportions in the categories were too low for meaningful interpretation.

Among women, CCEP participants were much more likely to receive a diagnosis in the categories of psychological conditions; signs, symptoms, and ill-defined conditions; and musculoskeletal conditions (by a factor of three or more). CCEP women were much less likely to receive a diagnoses of healthy (8.8% compared to 27%) or a diagnosis in the genitourinary group (3.6% compared to 10.0%). As with the men, it is difficult to assess the other diagnostic categories.

**Table 29. Frequency of Primary Diagnoses for CCEP and NAMCS, by Sex, for Subjects Aged 20-40 Years**

Primary Diagnosis	MEN Age 20-40 Percent Primary Diagnosis		WOMEN Age 20-40 Percent Primary Diagnosis	
	CCEP	NAMCS	CCEP	NAMCS
Psychological Conditions	18.0	7.1	18.0	5.6
Symptoms, Signs and Ill-Defined Conditions	18.0	3.5	17.0	3.2
Musculoskeletal System Diseases	19.0	9.1	16.0	5.3
Healthy	10.0	11.0	8.8	27.0
Respiratory System Diseases	6.7	11.0	6.1	10.0
Skin and Subcutaneous Tissue Diseases	6.3	8.7	6.3	7.2
Digestive System Diseases	6.4	5.2	4.8	3.0
Nervous System Diseases	5.4	9.2	9.0	7.4
Infectious Diseases	2.7	5.5	2.6	3.9
Circulatory System Diseases	2.1	3.2	1.6	2.0
Endocrine Disorders	1.8	2.1	2.6	2.8
Genitourinary System Diseases	0.9	4.6	3.6	10.0
Neoplasms	0.7	2.1	0.8	2.6
Injury and Poisoning	0.8	17.0	1.0	6.6
Blood and Blood Organ Diseases	0.4	0.2	1.7	0.3
Other	0.2	0.3	0.2	2.6

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Age	Gender	Ethnicity	Education	Occupation	Income	Health Status	Insurance	Access	Adherence	Outcomes
18-24	Male	White	High School	Unemployed	\$10,000	Good	Medicaid	High	85%	10%
25-34	Female	Black	College	Teacher	\$20,000	Fair	Medicaid	Medium	70%	5%
35-44	Male	Hispanic	High School	Construction	\$15,000	Poor	Medicaid	Low	60%	15%
45-54	Female	White	College	Nurse	\$25,000	Good	Medicaid	High	90%	8%
55-64	Male	Black	High School	Unemployed	\$12,000	Poor	Medicaid	Low	55%	18%
65-74	Female	White	College	Retired	\$18,000	Fair	Medicaid	Medium	75%	12%
75-84	Male	Hispanic	High School	Unemployed	\$10,000	Poor	Medicaid	Low	50%	20%
85+	Female	White	College	Retired	\$15,000	Fair	Medicaid	Medium	65%	15%
18-24	Male	Black	High School	Unemployed	\$10,000	Poor	Medicaid	Low	55%	18%
25-34	Female	White	College	Teacher	\$20,000	Fair	Medicaid	Medium	70%	5%
35-44	Male	Hispanic	High School	Construction	\$15,000	Poor	Medicaid	Low	60%	15%
45-54	Female	White	College	Nurse	\$25,000	Good	Medicaid	High	90%	8%
55-64	Male	Black	High School	Unemployed	\$12,000	Poor	Medicaid	Low	55%	18%
65-74	Female	White	College	Retired	\$18,000	Fair	Medicaid	Medium	75%	12%
75-84	Male	Hispanic	High School	Unemployed	\$10,000	Poor	Medicaid	Low	50%	20%
85+	Female	White	College	Retired	\$15,000	Fair	Medicaid	Medium	65%	15%

# DISCUSSION

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## Limitations in Interpreting Results of the CCEP

The CCEP represents an effort by DoD to complete a very large series of comprehensive medical examinations on Persian Gulf War veterans who request evaluation. As a result of proactive case finding and outreach efforts, DoD has conducted systematic medical evaluations on over 18,500 patients. This number includes approximately 3,000 patients who were referred to specialists for more extensive, sophisticated diagnostic workups at one of 14 tertiary care medical centers within the Military Health Services System.

The results of the CCEP characterize the nature of symptoms and the types of diagnoses in this select group of veterans and provide substantial clinical information to describe their general health. However, multiple methodological limitations associated with the CCEP need to be understood to interpret findings appropriately in this population:

- The CCEP population is not a homogeneous group, since it is composed of individuals with health complaints they believe may be related to their service in the Gulf War; others have no current problems but are concerned about their future health status, and a small number of CCEP participants have no current health problems or concerns but simply want to become part of the CCEP registry.
- Since the CCEP represents individuals who have self-selected to enter the program and excludes individuals who are not eligible for care through the military medical system, the CCEP population may not be representative of the overall population of PGW veterans. It is also likely that any Gulf War veterans who are very disabled by illness would no longer be on active duty.



- Throughout this report, findings of available studies on other populations are provided. None of these study populations are fully comparable to PGW veterans and thus any comparisons must be made with caution.
- A case series, such as the CCEP, is not definitive in determining causality or in specifically defining associations between health outcomes and specific risk factors.
- Lack of a case definition or other specific clinical criteria for participation in the CCEP limits the usefulness of inferences that may be drawn in attempting to discern a defined clinical syndrome.

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## Demographics

In terms of demographic characteristics, such as branch of service, sex, age and race, CCEP participants are a broad cross section of service members who deployed to Operations Desert Shield/Storm.

When the demographic characteristics of CCEP participants are compared against all those who deployed to the Persian Gulf, given the large sample sizes, a statistically significant difference was noted for each of the demographic variables (gender, race, age, marital status, rank, branch of service, status), with the exception of enlisted rank. Of interest are the observations that Army personnel, women, individuals over the age of 25, and Blacks appear overrepresented, while Navy personnel, Marines, and Whites appear underrepresented in the CCEP when compared to all other Persian Gulf War veterans.

Given the self-selected, non-random nature of participants in the CCEP, it is difficult to draw any meaningful conclusions from these demographic differences, other than to say that CCEP participants are a self-selected non-random sample of the Persian Gulf War veteran population. Only well-designed epidemiologic studies that compare the CCEP subpopulation with an appropriately matched comparison population will provide the best information on which to base

further investigations regarding any demographic differences. DoD, VA, and HHS have undertaken a number of epidemiologic studies to understand better the health consequences of service in the Gulf War. Appendix A lists the current DoD research projects.

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## **CCEP Participation Rates and Unit Identification Codes (UICs)**

The data comparing the exposures, symptoms, and diagnoses of members of units in the two lowest quintiles of CCEP participation with those of members of units in the highest quintile of CCEP participation provide little evidence of meaningful differences in self-reported exposures, symptoms, or diagnoses between the two groups. While members of the highest participation units reported more frequent exposures to tent heater fumes and antimalarial drugs, the meaning of this is not known. Both of these exposures were very widespread among CCEP participants in general, and these members did not report more symptoms or have more diagnoses.

UICs are in a sense rough surrogates for occupational, temporal, and/or geographic information. Analysis of CCEP results by unit of assignment is potentially an important area for further evaluation. As detailed geographic and temporal information becomes available in 1996, it will be possible to compare UICs in the CCEP population with a variety of epidemiologic and location variables. Examination of unit location by date with an integrated geographic information system (GIS) may be a more fruitful approach to assessing any possible associations between unit of assignment and CCEP participation rate and health outcome. These data could provide a basis for conducting case-control studies of specific outcomes and various exposures.

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## **Potential Exposure(s)**

Veterans' concerns regarding hazardous exposures which may have occurred during the Persian Gulf War have also been a concern of clinicians who have provided health care to Gulf War veterans. The experience of combat may involve exposure to a variety of potential health hazards. These exposures could include physical, chemical, and infectious hazards, and

psycho/social stressors. However, in general, the application of engineering controls in the design of military equipment, intensive training regarding the use of personal protective measures, and adherence to safe operating procedures are intended to minimize health risks associated with military operations. Service members knowledgeable about specific exposures can provide useful information for correlation with symptoms and diagnostic findings. However, interpreting the clinical significance of these self-reported exposures must be considered within the context of available pharmacologic, toxicologic, clinical, and epidemiologic information.

Although exposure to chemical and biologic warfare (CBW) agents has been hypothesized as a possible cause of ill health, both DoD and the Defense Science Board Task Force have concluded that there is no persuasive evidence for exposure of U.S. troops to such agents.<sup>4</sup> This conclusion is based on a number of factors including the fact that no characteristic casualties were reported. A recent independent evaluation by the Institute of Medicine, National Academy of Sciences concluded: "In light of this negative evidence from highly placed sources, claims of exposure to chemical or biological warfare agents should not be made or given credence in the absence of reliable data to the contrary."<sup>23</sup>

Pyridostigmine bromide (PB) has been hypothesized to be a possible cause of chronic illness in Gulf War veterans. Troops were provided PB during the Persian Gulf War to help protect against the lethal effects of CW nerve agents.<sup>24</sup> Though this Food and Drug Administration (FDA) approved drug is not licensed for this military use, it has been approved by FDA under investigational new drug (IND) provisions. It has been used since the 1950s in anesthesia and for myasthenia gravis in doses as high as ten times those taken by troops during the Persian Gulf War, without any long-term effects. In addition, studies of this drug when taken in low doses have not revealed any serious, chronic side effects.<sup>25,26,27</sup> Whether or not pyridostigmine bromide and other chemicals such as DEET might have interactive effects at the dosage administered during the Gulf War is unclear at this time. Additional research studies are underway on this question.

Two vaccines, botulinum toxoid and anthrax, also have been postulated to be possible causes of ill health among Persian Gulf veterans. The botulinum vaccine is not believed to be a likely

cause of veterans' health concerns since it has previously been used without evidence of chronic complications and was given to only 8,000 troops in the Gulf. While not licensed by the FDA for use in protecting troops against botulinum toxin, botulinum vaccine was approved for use during the Gulf War under the provision of an FDA investigational new drug. The FDA-licensed anthrax vaccine has been used for several decades without any major adverse effects.<sup>28,29</sup>

A total of 12 cases of viscerotropic leishmaniasis and 20 cases of cutaneous leishmaniasis have been diagnosed among U.S. troops.<sup>8</sup> Although difficult to diagnose, leishmania infection is not considered to be a cause of widespread illness because most troops with documented leishmaniasis have had characteristic, objective signs of disease, including elevated temperature, lymphadenopathy, hepatosplenomegaly, and skin rash.<sup>30</sup> Currently, no other infectious diseases have been demonstrated to cause chronic morbidity among a significant number of Persian Gulf veterans.<sup>31</sup>

Desert Storm troops were exposed to several potentially hazardous chemical compounds in the Gulf, most notably smoke from 605 oil well fires. However, studies conducted thus far indicate that the health risks from exposure to oil fire smoke were minimal because of the lofting of the smoke above ground level and nearly complete combustion of most chemical substances.<sup>15,32</sup>

U.S. troops were also exposed to low levels of several pesticides that are routinely used in the commercial market and by DoD. Long-term sequelae from these pesticides have been found only when exposure was very high and caused acute illness, but no acute toxicity due to pesticide exposure was reported among coalition troops during ODS/S. Nevertheless, the possibility that pyridostigmine bromide in combination with such pesticides could have acute or chronic effects is being investigated.<sup>20</sup>

Another unique, potential environmental hazard of the Gulf war was exposure to depleted uranium (DU) munitions. DU poses little health risk when external to the body. However, there may be some risk resulting from aerosolization when DU impacts on armored targets or catches fire. There were 35 U.S. soldiers in vehicles struck by DU, and approximately 32 other U.S. soldiers were potentially exposed while fighting a fire in a munitions storage area and from

servicing vehicles hit by DU munitions.<sup>4</sup> Other ground-based troops are not considered to be at risk because of the very low levels of radiation associated with DU munitions.<sup>4</sup>

Some Persian Gulf troops may have been exposed to a number of other potential environmental hazards, including microwaves; chemical-agent-resistant-coating (CARC) paint vapors containing isocyanate; various petroleum products; and airborne allergens and irritants.<sup>33</sup> At this time, none of these exposures has been identified as a primary cause of illness, because the exposures involved small numbers of troops and low concentrations of agent were involved and because there was no evidence of acute illness reported in-theater. In addition, such substances are not known to cause the types of chronic illnesses reported by Gulf War veterans.<sup>4,15,20</sup>

The Gulf War setting was quite threatening and there were many situations where participants had good reasons to be fearful. U.S. troops encountered an extremely harsh desert environment, where they were crowded into warehouses and tents with little personal privacy and few amenities. No one knew that coalition forces eventually would win a quick and decisive war. Most troops did not fight a "four-day war," but spent months isolated in the desert, under constant stress and uncertain about their own survival and the well-being of their families.<sup>34</sup> From the outset of the deployment, active duty service members and reservists heard media reports about the devastating capabilities of Iraqi chemical and biological weapons. In anticipation of possible SCUD attacks, and in response to required training and false alarms from sensitive chemical detection devices, service members repeatedly donned cumbersome gear designed to protect them from such weapons, making life even more difficult.

In spite of these stressful conditions, Army medical evacuations for psychiatric reasons were considerably lower (2.7/1000 evacuations per year)<sup>4,35</sup> than seen in previous conflicts.<sup>36</sup> However, several months after the war, some clinicians began to report mild cases of PTSD among Gulf War veterans who did not have previous psychiatric histories.<sup>4,10,13</sup> PTSD has been previously diagnosed in other populations that have experienced a traumatic event.<sup>4,37,38,39,40,41</sup>

Although participants self-report a wide range of exposures, no objective information was available through the CCEP regarding the intensity, frequency, duration, or any routes of

exposures that could further characterize actual health risks. Since exposure data generally was not collected during the Gulf War, most self-reported exposures cannot be validated or confirmed. Difficulties in interpreting self-reported data include problems involving uncertainty about the identity of hazards; inadequate information about exposure level; and recall bias (greater attention to exposures that were at the time frightening or uncomfortable, or perceived as being threats to health or life). For at least some of the potential exposures, there is independent and objective data that is discordant with CCEP participants' self-reported exposures, so that the latter may considerably overestimate actual exposure.

For example, several of the potential exposures that occurred in the Persian Gulf (as self-reported by CCEP participants) were restricted to a limited number of units involved in specialized occupations or certain geographic locations and/or to unique circumstances involving relatively small numbers of individuals. Malaria prophylaxis was provided only to selected units based upon geographic location, primarily those situated in southern Iraq, yet 22% of CCEP participants indicate they received it. With respect to DU, only approximately 30 individuals are known to have been exposed to DU fragments as a result of injuries, yet nearly 15% of CCEP participants report exposure to DU. The extent to which additional exposures to DU could have occurred is unknown. In the case of CARC paint, approximately 47% of CCEP participants report exposure, although only approximately 1000 individuals were assigned to the in-theater maintenance operations involved in the industrial application of this material. Continued analysis of the CCEP population by UIC-specific locations and military occupational specialty groups should help clarify how to interpret these self-reported exposures.

To support the latter effort, the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) is currently integrating exposure data sets, troop movement data, and satellite imagery of the oil well fire period into a geographic information system (GIS) model, thereby enabling spatial and temporal analyses. Additionally, information from operational, intelligence, medical sources, research databases, and anecdotal accounts of veterans is being correlated with CCEP and GIS findings to further clarify possible relationships among troop location(s), exposures, and clinical findings among Persian Gulf veterans.

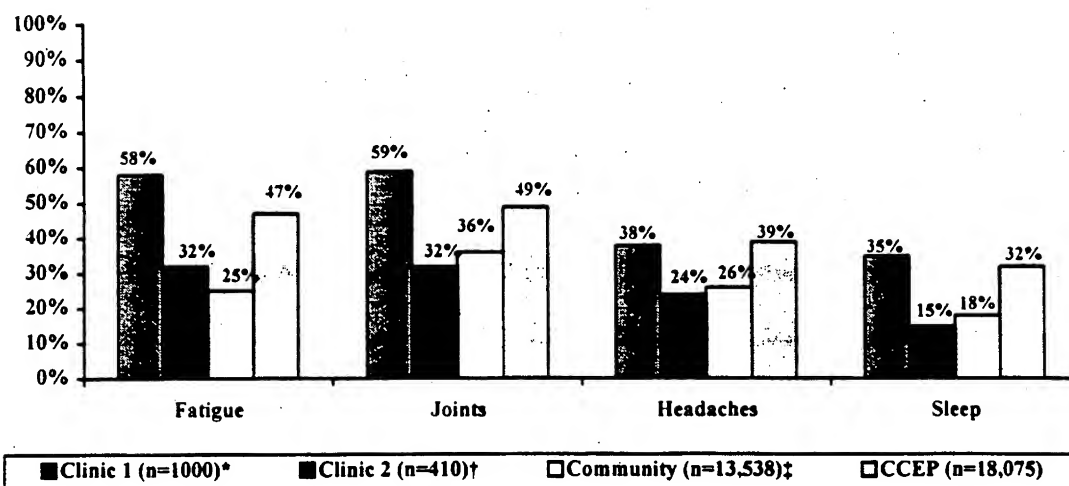
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## Symptoms

CCEP participants reported a wide variety of symptoms that span various organ systems. The most commonly reported symptoms include fatigue, joint pain, headaches, rash, and sleep disturbance. The median number of reported symptoms per CCEP participant was five. As presented in previous CCEP reports, there appears to be a strong consistency in the types of reported symptoms between other large population studies of outpatient medical clinics and symptoms reported by CCEP participants. However, other large population studies of outpatient medical clinics typically include much older patients. Moreover, women are usually the majority in these community samples, since women are more likely to seek medical care than men.

Although the limited published studies of symptoms of patients in other clinical and survey settings are not fully comparable to the CCEP program, clearly these do suggest that the types of symptoms reported in the CCEP are not unique to this group.<sup>42,43,44</sup> However, comparison samples tend to average at least 20-25 years older and frequently include very elderly patients. For example, Figure 5 presents data from three community samples. Clinic 1, a study of 1000 patients who received care at four primary care clinics in the U.S., reported that 58 percent of patients reported fatigue, 59 percent reported joint pain, and 35 percent reported sleep disturbances. The comparable percentages for the CCEP are 45 percent, 49 percent, and 32 percent, respectively. However, the community sample averaged 55 years of age and ranged in age up to 91 years old. The CCEP average age was 34, and participants ranged in age up to 68. Similarly, in Clinic 2, a study of 410 patients attending a military general medicine clinic with an average age of 61.4 years, 32 percent reported fatigue, 32 percent reported joint pain, and 15 percent reported sleep disturbances. The publication describing Study 3, which includes 13,538 individuals, does not include an average age, but reports that 14.5 percent are 65 or older. This study differed from the other community studies and the CCEP in that these individuals were randomly selected from five communities and were not necessarily seeking medical care at the time they were studied. In the third study 25% reported fatigue, 36% reported joint pain, and 18% reported sleep disturbances.

**Figure 5. Common Symptom Prevalence as Reported in Three Studies of Outpatient Practice in the United States, as Compared with CCEP**



\* Clinic Survey 1 = 1000 patients presenting for care at four primary care clinics in the U.S.

† Clinic Survey 2 = 410 patients attending a military general medicine clinic.

‡ Community Survey 3 = Random survey of 13,538 persons in four communities in the U.S.

Since fatigue, joint pain, and sleep disturbances are all associated with age, the similarities and difference between the CCEP and the community sample and military medical clinic are difficult to interpret. While clearly indication that the CCEP participants do not suffer from unique ailments, these comparisons suggest that the percentage of CCEP participants with such symptoms is unusually high, particularly for individuals of that age group. Headaches, which are less likely to be age-related, were reported by 38 percent of the participants of Clinic 1 and 39 percent of CCEP participants, but only 24 percent and 26 percent of the other two community surveys. Since headaches are a common symptom, it is important to know how this question was asked and whether the CCEP participants were reporting chronic headaches or headaches that differed in any way from those reported by the other three samples.

Patients commonly report experiencing multiple symptoms. Studies have shown that when patients complete symptom checklists, one-third of patients complain of 0-1 symptom, one-third complain of 2-3 symptoms, and one-third complain of 4 or more symptoms.<sup>43,46</sup> Research conducted by Kroenke et al. indicates that typical outpatients will endorse a median of 4 symptoms as bothersome.<sup>44,47</sup> CCEP patients report a median of 5 symptoms per patient.



It is important to note that physical symptoms in both clinic patients and the general population frequently lack a clear-cut or definitive physical explanation or "cause." Four community-based studies have shown that 20% to 75% of symptoms lack an association with a definitive diagnosis after a medical evaluation.<sup>42,44,46,47</sup> A reasonable estimate in general outpatient practice is that about one-third of symptoms cannot be linked to a defined diagnosis. Carefully designed studies using appropriate comparison groups will help determine whether the symptoms reported by Gulf War veterans are unique in character, frequency of occurrence, and patterns of association.

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## **Diagnoses**

The types of primary diagnoses commonly seen in the CCEP involve a variety of conditions such as tension headache, fatigue, depression, PTSD, nonspecific headache, migraine, joint pain, asthma, irritable colon. These primary diagnoses span all diagnostic categories of the ICD-9-CM. However, over half (65%) of all primary diagnoses fall into four diagnostic groups: psychological conditions; musculoskeletal diseases; symptoms, signs, ill-defined conditions; and healthy.

Eighty percent of CCEP participants received more than one diagnosis. About 20% of CCEP participants received a single primary diagnosis. For individuals with a primary diagnosis of respiratory; symptoms, signs, ill-defined conditions; musculoskeletal diseases; or psychological conditions a frequency distribution of secondary diagnoses indicates that the additional diagnosis is most likely to be in the same ICD-9 category as the first (primary), generally followed by musculoskeletal, psychological, or ill-defined.

## **Psychological Conditions**

The most frequent primary diagnostic category in the CCEP population is psychological conditions. The most frequent psychological conditions are somatoform problems, especially tension headache; nonspecific, mild, or stress-related anxiety and/or depression; posttraumatic stress disorder; and alcohol-related disorders (Table 30).

**Table 30. Most Frequent Psychological Conditions among CCEP Participants (N=18,075)**

Psychological Condition	CCEP	
	Primary Diagnosis (%)	Any Diagnosis (%)
Somatization Disorder	0.6	1.5
Tension Headache	3.4	11.3
Mood Depression	2.9	6.2
Major Depressive Disorder	1.8	3.0
Neurotic Depression	1.1	3.0
Anxiety Disorders	0.7	2.2
Posttraumatic Stress Disorder	2.8	5.2
Adjustment Disorders	1.3	2.5
Substance Related Disorders	0.3	2.9
Alcohol Related Disorders	0.4	1.7

Psychological conditions such as depression, anxiety, and somatoform disorders are common in primary care, existing in 25-35% of all patients presenting for care, in the outpatient setting.<sup>50,51</sup> However, direct comparison with the CCEP population is confounded by differences in age, gender, and ethnicity.

The prevalence of psychological conditions in CCEP participants may be increased because patients with persistent or unexplained symptoms have high rates (50% or more) of underlying mood or anxiety disorders. This need not always mean that the symptoms are caused by the mood or anxiety disorder, since it is possible that depression or anxiety can be a consequence of persistent, disabling physical symptoms. Nonetheless, the mood or anxiety disorders that coexist in half or more of such patients can further aggravate such symptoms through worsening sleep, increased fatigue, lowered pain tolerance, and mental suffering.

Patients complaining of unexplained or ill-defined physical symptoms may have coexisting conditions with associated depression and anxiety. Studies have demonstrated that ill-defined (compared with better-defined) symptoms or syndromes tend to occur much more frequently in individuals with common, treatable anxiety and depressive disorders.<sup>50,51</sup> The severity of ill-

defined symptoms associated with depression and anxiety commonly diminish in response to treatment of the underlying psychiatric condition.

## **Musculoskeletal Diseases**

The second most common primary diagnostic category within the CCEP population is musculoskeletal disease. Primary diagnoses coding within the musculoskeletal area accounted for 18% of the primary diagnoses in the CCEP. This group includes autoimmune disorders such as rheumatoid arthritis, systemic lupus erythematosus, and Sjorgen's syndrome; degenerative disorders such as degenerative joint disease and osteoarthritis; and traumatic, disuse, or overuse inflammatory conditions such as tendonitis, bursitis, patellofemoral syndrome, and lower back pain.

Review of the CCEP population reveals that autoimmune disorders are very rare as either primary or secondary diagnoses. The most common primary diagnosis within this group is arthralgia (2.96% of all primary diagnoses) followed by degenerative joint disease/osteoarthritis (2.52%). Complaints about a specific joint (particularly the knee) are common, as are tendonitis and bursitis. These diagnoses are not inconsistent with the expected morbidity to be seen in a population of military members.

Fibromyalgia is a syndrome of unknown etiology that manifests as widespread pain with specific tender pressure points. It is associated with painful but nonarthritic joints. It is also associated with poor sleep hygiene and nonrestorative sleep. Of the CCEP participants, 1.53% have been diagnosed with fibromyalgia as either a primary or secondary diagnosis. This rate does not differ from that of the general population as a whole.<sup>52</sup>

The majority of diagnoses falling within the musculoskeletal group are wear-and-tear disorders (recurrent strains, sprains, and other chronic degenerative conditions) that should be expected in physically active military populations. There is no evidence of autoimmune disorders precipitated by exposures in the Persian Gulf. While the musculoskeletal category is the third most commonly occurring diagnostic group, the disability of this group is not significant. Only

19.2% of the participants with a primary diagnosis in this group indicated they had missed work in the 90 days prior to their CCEP exam. Only 7% had lost seven or more days. Of the four most common categories, only "healthy" had fewer days lost.

### **Symptoms, Signs, and Ill-Defined Conditions**

The third most common diagnostic category of primary diagnosis of CCEP participants is the category of symptoms, signs, and ill-defined conditions. Approximately 18% of CCEP participants have primary diagnoses in this ICD-9-CM category. This category includes symptoms, signs, ill-defined conditions, abnormal laboratory results or other investigative abnormalities which are not elsewhere classified in the ICD-9-CM. Although an illness or symptom may fall in the 780-799 ICD-9-CM code range, that illness or symptom may very well represent a well-defined condition not classified elsewhere (such as obstructive sleep apnea or a nonspecific laboratory abnormality, e.g., elevated sediment rate). However, this ICD-9-CM category also includes patients with persistent symptoms whose physical examinations and diagnostic testing did not provide a diagnosis. Patients such as these often end up with a "symptomatic" diagnosis, e.g., malaise and fatigue, lower back pain, or headache, rather than a more precise, anatomic or pathophysiologic diagnosis.

Within the CCEP, it is apparent that many of the patients with multiple diagnoses commonly have a secondary diagnosis in the symptoms, signs, ill-defined conditions category.

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## **Characterization of Individuals with More Than One Diagnosis**

Eighty percent of CCEP participants received more than one diagnosis. In an effort to characterize, clinically, the pattern of diagnoses in some of these individuals, the frequency distribution of secondary diagnoses was examined for patients with a primary diagnosis in one of the four major diagnostic categories (psychological conditions; musculoskeletal diseases; symptoms, signs and ill-defined conditions; or respiratory). Analysis of the frequency

distribution of secondary diagnoses in this group of patients displays a rather consistent pattern involving three prominent features:

- The initial secondary diagnosis is most likely to be in the same ICD-9-CM category as the primary.
- Diagnoses involving musculoskeletal diseases; psychological conditions; and symptoms, signs, and ill-defined conditions are prominent as secondary diagnoses irrespective of the primary diagnosis.
- The proportions of other ICD-9 categories (excluding musculoskeletal diseases, psychological conditions, and symptoms, signs, and ill-defined conditions) remain relatively constant and at a relatively low level regardless of the primary diagnosis.

These observations are consistent with earlier analyses of the CCEP results, which have shown that diagnoses involving musculoskeletal diseases; psychological conditions; and symptoms, signs and ill-defined conditions are predominant conditions within the CCEP population overall. The current analysis confirms that this pattern is repeated within the major diagnostic categories as well, and shows that CCEP patients with multiple diagnoses commonly have a secondary diagnosis in the same organ system as the primary diagnosis. The latter observation seems consistent with clinical experience in that the manner in which physicians determine the rank order of diagnoses is based on the severity of the medical condition and the relative contribution of additional diagnoses to the overall clinical presentation.

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## **NAMCS Comparison**

The prominent differences that exist between the NAMCS and CCEP populations among many of the diagnostic categories may be explained when the unique characteristics of these groups are considered. Most of the military personnel within CCEP probably face markedly different occupational experiences than most civilians found within the NAMCS population. There are

also likely to be more clinical visits for acute and routine health care needs in randomly selected civilian populations like NAMCS.

CCEP participants experienced a difficult occupational experience unlike that of their civilian counterparts, e.g., deployment to the Persian Gulf region. Numerous studies have established the impacts this type of setting may have on an individual, including the development of a number of psychological symptoms and psychiatric diagnoses<sup>53,54,55</sup> and various symptoms that cannot be associated with a definitive diagnosis.<sup>56,57,58</sup> This would explain the higher percentage of psychological conditions and symptoms, signs and ill-defined conditions within the CCEP population. Psychological conditions may also be more common within the CCEP population because standardized instruments are used routinely, and use of these may increase the physician's likelihood of giving a psychological diagnosis.

Service members must maintain certain levels of physical fitness, and many are required to participate in demanding training programs, placing considerable stress on muscles and joints. These mandatory activities may account for the increased prevalence of musculoskeletal conditions in the CCEP population.

The differing reasons people seek health care may provide reasonable explanations for the higher percentages of individuals with respiratory system diagnoses in NAMCS. In most instances, people presenting to the CCEP are concerned about persistent problems. On the other hand, the randomly selected patients who visit physicians surveyed in NAMCS may present for a wide variety of reasons. For example, people may seek health care for an acute problem, one of the most common of which is an upper respiratory illness. This could account for the higher percentage of respiratory system diagnoses. Many individuals may see a health care provider for a routine or required physical examination and not have an acute condition of any kind, resulting in a relatively high percentage of people with healthy diagnoses, as seen among females in NAMCS as compared to CCEP. In previous comparisons made between NAMCS and CCEP populations, gender was not considered, and the higher percentages of genitourinary system diagnoses within NAMCS were considered to possibly reflect the larger proportion of women in that survey.<sup>7</sup>

Standard reasons for outpatient visits in the civilian sector may also account for the higher percentage of people with diagnoses of injury and poisoning in the NAMCS population. Such patients are acutely ill or injured, come in promptly for care, and are treated within a matter of hours to a few days. Thus, these would be common in an office practice seeing acute and chronic patients, but would be rare in a sample of patients with persistent symptoms, such as the CCEP.

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## Physicians' Review

DoD physicians who are specialists in the areas of respiratory disorders, dermatology, neurology, infectious diseases, sleep disorders, and memory problems were asked to review the diagnoses in their clinical areas of expertise. The comments that follow reflect their impressions of the CCEP results within the broad context of their overall clinical experience.

### Respiratory Disorders

A primary diagnosis of a respiratory disorder was the fifth most common diagnostic category among CCEP participants, following the diagnostic categories of psychological conditions; musculoskeletal diseases; symptoms, signs, and ill-defined conditions and healthy. Non-infectious respiratory conditions were reported as 3,693 primary or secondary diagnoses in the first 17,370 CCEP participants completing their evaluation. The most common respiratory diagnosis was allergic rhinitis at 6% followed by asthma at 4.7%. Cases of sinusitis, both acute and chronic, accounted for 757 or 4.3% of the diagnoses. When reactive and obstructive airway diseases were combined, they accounted for 6.1% or 1,074 diagnoses.

Any attempt to compare these frequency distributions to other cohorts is fraught with difficulty. Most other cohorts report disease occurrence as either age-adjusted prevalence or incidence, which was not available in this CCEP analysis. Lacking a control group (especially controlling for such factors as age, gender, ethnicity, etc.), great care must be taken in comparing CCEP participants with other populations.

Given these cautions, certain general comparisons may be made with this initial data. In the United States, the overall age-adjusted prevalence rate of self-reported asthma was 4.94%.<sup>59</sup> The non-adjusted prevalence of asthma in this CCEP analysis is 4.7%. Emphysema was reported in 15 participants in the CCEP. When combined with the diagnoses of chronic bronchitis and chronic airway obstruction, the number rose to 249, for a frequency distribution value of 6.7%. The number of cases of pulmonary fibrosis, 44, was low. Some respiratory conditions reported, e.g., deviated nasal septum (N=91) probably existed prior to and independent of service in the Gulf War. Finally, the occurrence of respiratory conditions, such as rhinitis and asthma, in a dusty environment such as exists in the Persian Gulf region may have some connection, but extensive investigation and additional data are necessary before any firm conclusion may be reached. No definitive etiology for any of these respiratory conditions reported in the CCEP may be identified based on this specific analysis.

### **Dermatologic Conditions**

The seventh most common diagnostic category among CCEP participants was dermatologic conditions. The most common dermatologic conditions in the CCEP in decreasing order were eczema/dermatitis, alopecia (predominantly common balding), folliculitis (predominantly pseudofolliculitis barbae), seborrheic dermatitis, acne, benign cysts, and xerosis/sebaceous hyperplasia.

Diseases such as malignant neoplasms of the skin may be underrepresented in the CCEP population, probably because of the young age of this population. Serious infections were also underrepresented. Psoriasis is probably underrepresented because the condition (or a history of the condition) commonly excludes persons from entry into the armed forces. Diseases such as pseudofolliculitis barbae were overrepresented because the CCEP population was a military population consisting of male service members required to shave on a daily basis to meet military standards.

According to *Dermatology in General Medicine*, fourth edition, 1993, edited by T.B. Fitzpatrick et al., the true prevalence of skin disease is difficult to determine. This is because many



dermatologic studies involve selected populations, usually patients who present with a skin complaint or who are confined to a hospital or other institution. In addition, varying social and environmental factors can influence disease occurrence or detection. The dermatologic conditions in the CCEP population closely mirror the dermatologic conditions seen in general practice.

## **Neurological Diagnoses**

The eighth most common diagnostic category of CCEP participants was neurological disorders. Headache was reported as a frequent complaint of many CCEP participants. The most common neurological diagnosis was migraine headache which accounted for 63% of the neurological diagnoses and 7.7% of all CCEP diagnoses. This prevalence was low compared to estimates in the general population. The second most common diagnosis, ulnar neuropathy or carpal tunnel syndrome, accounted for 9.5% of neurological and 1.3% of all diagnoses in CCEP.

Several other diagnoses were common in the CCEP. Benign essential tremor accounted for 2.3% of the neurological diagnosis. Nocturnal myoclonus (0.36%), narcolepsy (0.16%), and Bell's palsy (0.05%) were diagnosed in the CCEP population. Peripheral neuropathies were diagnosed in 0.25% of the CCEP population, and do not appear overrepresented. As a definitive diagnosis, multiple sclerosis (MS) was diagnosed at a frequency of 0.1%; however, if the diagnoses of possible demyelinating diseases are counted as MS, the incidence is 0.14%.

## Infectious Diseases

A primary diagnosis of an infectious disorder has been made in a very small proportion of Persian Gulf veterans examined. Of the 17,370 individuals evaluated, 392 (2.3%) received a primary diagnosis of infection with some pathogenic agent. The specific infections identified in these 392 patients varied widely. Most of these infections, 233 or 59.4%, were common dermatophytic infections. Other skin infections, such as yeast, warts, and scabies, comprised another 28 or 7.1% of the primary infectious diagnoses.

Systemic infections were reported for 131 or 33.4% individuals receiving primary infectious diagnoses. Of these, hepatitis C and/or hepatitis C infection was the most common individual diagnosis, identified in 44 or 11.2%. Giardiasis, proven or probable, was diagnosed in 13 or 3.3% and *Helicobacter pylori* infections in 7 or 1.8% of patients. In the remaining 67 patients (17.1%) with primary diagnoses of systematic infections, a wide, and apparently unrelated, variety of diagnoses were made. No other single infection was the primary diagnosis in more than five patients.

The threat to deployed military personnel posed by infectious diseases was recognized, and prepared against, from the earliest stages of Operation Desert Shield. Specific diseases observed in U.S. troops during Operations Desert Shield/Storm conformed with expectations, except that incidence was generally lower than expected. During these operations, gastrointestinal illness predominated. Attack rates ranged up to 4% per week for some units deployed early, but dropped to less than 0.5% per week when control of food sources was tightened. Limited data suggest that sexually transmitted diseases occurred at a relatively low rate. Major respiratory illnesses were rare. Insect and tick-borne illnesses, a major concern, were rarely observed in theater. Only seven cases of malaria, and only one case of West Nile fever, a mosquito-borne viral illness, were detected. No rickettsial illnesses, and no other arthropod-borne viral illnesses were identified. By October 1991, 14 cases of leishmanial disease had been diagnosed, a rate substantially lower than had been anticipated based on prewar epidemiological and historical information.

This record of infectious diseases observed during the operations themselves is relevant to current complaints of Gulf War veterans. This record suggests that overall exposure to recognized pathogens was quite low. Furthermore, it suggests that no route of infection, other than ingestion of tainted food or water, was common.

## **Sleep Disturbances**

A primary diagnosis of sleep disorder was given to 4.2% of CCEP patients. Thirty percent of the primary diagnoses within the sleep disorder category, ICD-9-CM 307.4 and 780-786.09, were diagnosed as obstructive sleep apnea (ICD-9-CM 780.57). The remainder of sleep disorder categories were evenly distributed for primary diagnosis. Within the symptoms, signs and ill-defined conditions, ICD-9-CM 780-799 code range, sleep disorders were recorded in 18.6% of the diagnoses in this category.

Many epidemiological studies concerning sleeping habits have been done since 1960 in the United States and other parts of the world. The complaint of sleep disturbance is common and is reported in these studies to range between 30% and 40%.<sup>60,61,62,63</sup>

Sleep disorders represent a recognized group of medical conditions that have been internationally classified. Also, each sleep disorder has specific medical therapies that can potentially correct that condition.<sup>60</sup> One example is obstructive sleep apnea, which is characterized by repetitive apneas during sleep as a result of an anatomical obstruction. Obstructive sleep apnea can be successfully treated by various modalities, including surgery, continuous positive airway pressure (CPAP), or weight loss.

Sleep deprivation has been shown to be associated with many health problems, including poor self-rated health, depression and anxiety, chronic medical conditions, and all-cause mortality.<sup>64</sup> Sleep deprivation has also been associated with a variety of work-related problems, including higher absenteeism, decreased job performance, and lower satisfaction.<sup>63,65</sup> In a recent sleep survey of 588 employees of a San Francisco Bay Area telecommunications firm (mean age approximately 36 years), a significantly higher frequency of physical conditions, especially

headaches, neck or back pain, muscle pain, and gastrointestinal problems, were found in those reporting sleep problems. Also noted was a higher frequency of mental health conditions (anxiety, depression) in those individuals with reported sleep disturbances.<sup>63</sup> CCEP participants share many of the physical and psychosocial complaints listed above. Sleep disorders have been actively sought by CCEP physicians and a number of sleep disorders have been diagnosed and treatments instituted. Sleep questions have also been added to the CCEP health questionnaire to help screen for sleep disorders.

## Memory Complaints

Although memory loss was recorded as the primary diagnosis in 1.7% of CCEP participants, comprehensive neuropsychological evaluations have identified no patient with evidence of an underlying neurologic etiology. All group memory scores were within the normal range for one random sample (n=165) of participants receiving neuropsychological screening with *MiroCog*<sup>66</sup> at Wilford Hall Medical Center.<sup>†</sup> There were no significant differences between patients with (n=120) and without (n=45) memory complaints on all of these measures.<sup>‡</sup>

Within the ICD-9-CM 780-799 code range (symptoms, signs and ill-defined conditions), memory dysfunction accounted for 12.3% of primary diagnoses. Most of these diagnoses appeared to be based on subjective information alone, e.g., "memory loss without cognitive deficit," which would not normally be recorded as clinical diagnoses in medical records. This tendency to diagnose memory problems in CCEP participants despite the absence of objective data may significantly inflate the incidence of this ICD-9 category in the Gulf War veteran population.

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<sup>†</sup> MicroCog Memory Index standard score 97.35; Story Immediate Recall standard score 8.53; Story Delayed Recall standard score 8.64; Percent Retention standard score 10.19.

<sup>‡</sup> Memory Index  $f = 3.43$ ,  $p = .066$ ; Story Immediate Recall  $f = 1.6$ ,  $p = 2.08$ ; Percent Retention  $f = 1.93$ ,  $p = 166$ .

Memory complaints are associated with a number of non-neurologic medical conditions seen within the CCEP population, including sleep disorders,<sup>67</sup> chronic fatigue,<sup>68</sup> posttraumatic stress syndrome,<sup>69</sup> depression, and chronic pain. Preliminary analysis of the Wilford Hall Medical Center neuropsychological data indicates that reduced memory performance is related to higher levels of psychological maladjustment,<sup>†</sup> distress,<sup>‡</sup> and psychiatric conditions.<sup>††</sup> These represent potentially treatable causes of memory dysfunction, whereas neurologically based memory disorders are considered irreversible.

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## Disability

Severe disability measured in terms of lost workdays and/or referral to the disability evaluation system is not a major characteristic of the CCEP population as a whole. CCEP participants report a relatively low number of lost days, and this does not appear to vary with organ system involvement. Relatively few CCEP participants have undergone a disability processing action. For participants who have undergone disability processing actions, information is not readily available as to whether the medical conditions being evaluated are preexisting or are related to Persian Gulf War service. Determination of the degree to which the Physical Evaluation Board (PEB) experience reflects the overall disability experience of Persian Gulf veterans is limited by the fact that many Persian Gulf War veterans are no longer on active duty, and those that are not may represent some of the more severely disabled.

When comparing categories of diagnoses of CCEP participants who met a PEB to diagnostic categories of participants who did not, the diagnostic pattern does not appear to be different except in the categories of psychological conditions; musculoskeletal diseases; and symptoms, signs and ill-defined conditions. These three categories occur at higher frequencies relative to our overall CCEP population. Further analysis is needed to interpret these differences.

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<sup>†</sup> MMPI-2 A scale x MicroCog Memory Index,  $r = -.194, p = .003$

<sup>‡</sup> MMPI-2 F scale x MicroCog Memory Index,  $r = -.272, p = .000$

<sup>††</sup> Diagnosis x MicroCog Memory Index,  $f = 11.46, p = .0008$

Some CCEP patients with severe disability may benefit from participation in special programs that focus on rehabilitation, restoration of function, and promotion of general well-being. The DoD has established Specialized Care Centers, staffed by interdisciplinary teams, to provide such programs.

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## Reproductive Outcomes

For the 8,819 CCEP participants who responded to both the pre- and postwar reproductive outcomes questions, there were increases in self-reported infertility, miscarriages, and birth defects. The interpretation of these data is problematic for a number of reasons. For example, the frequency of self-reported birth defects among the children of just CCEP participants after the war was 2.6%. This is actually lower than what was observed when analyses were conducted using discharge diagnoses from the review of medical records when Gulf War veterans were compared with Gulf War veterans.<sup>70</sup> Several possible reasons for these inconsistencies are discussed below.

The use of self-reported pre- and postwar reproductive events does not ensure either internal or external accuracy or validity, particularly given the self-selected nature of the study population. Participation in the CCEP is voluntary, and persons deciding to participate in a clinical examination could also be expected to self-report high rates of adverse reproductive conditions. If these events occurred after the war, it is reasonable for these persons to actively participate in the CCEP. However, without a comparison group it is too early to assume any causal association between the deployment and adverse reproductive outcomes. As has been mentioned previously in this report, the CCEP and the data collection instrument were not designed for research. The questionnaire was not constructed to account for other factors that could affect the responses. For example, the question related to infertility does not ask whether the subject has been examined or diagnosed with infertility, whether unprotected (or any) intercourse was occurring, or whether the subject was trying to conceive children. Also, each of the reproductive questions is open to substantially differing interpretations by the CCEP participants. Additionally, even

though most of the reproductive questions were answered by males, the information concerned female outcomes.

The frequencies of reproductive outcomes varied among different groups, when classified by race/ethnicity, age, marital status, and branch of service. Further, there are time-dependent confounding variables, such as age and changing marital status, and intent to have children, which would likely affect the frequency of some or all reproductive events over time. The presence of these uncontrolled confounders, individually or interactively, often precludes accurate interpretation of self-reported findings.

The questionnaire design and self-selected nature of the CCEP population prevent the calculation of estimates of the prevalence or risk of any reproductive events in the population of Gulf War veterans. Well-designed epidemiologic studies, comparing events among a random sample of Gulf War veterans (including those no longer on active duty) to an appropriate group, such as military personnel who did not participate in the war, are required to determine whether there is an association between Gulf War service or experiences and the risk of adverse reproductive outcomes. Several studies have already been conducted or initiated to address the broader questions of risk of adverse reproductive outcomes.

The CCEP includes 35 children with congenital abnormalities whose parents chose to enroll them in the program. These birth defects include a wide range of conditions and are not concentrated in any single organ system or congenital syndrome. Given the self-selected population in the CCEP, other Gulf War reproductive outcome studies shed light on this issue.

Investigations by state and national public health agencies and DoD have identified no elevated rates or unusual patterns of birth defects in babies born to Gulf War veterans or their spouses. For example, one study of 23 preterm labor cases with 41 matched controls (all of whose husbands had served in the Persian Gulf during ODS/S) failed to demonstrate a significant association between Gulf War service of the husband and preterm labor in the wife.<sup>71</sup> Another study, of 54 children born to Persian Gulf veterans, conducted by the Centers for Diseases Control and Prevention (CDC), the Mississippi State Department of Health, and the Department

of Veterans Affairs found that the prevalence of birth defects, premature birth, low birth weight, and other health problems among children of Mississippi Army National Guard members appeared to be similar to that found in the general population.<sup>72</sup> In yet another study, of 41,000 live births occurring in military hospitals, researchers found that the risk of birth defects noted on medical records was no higher for either men or women who served in the Gulf War than for men or women in the military who were not Gulf War veterans, and there was no association between duration of time in the theater and the risk of birth defects.<sup>70</sup> These initial epidemiologic studies conducted to date do not indicate any association between Gulf War service and risk of adverse reproductive events.

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## **Individual and Group Response to Environmental Factors Contributing to Health Consequences Among CCEP Participants**

The medical and psychological responses individuals may have after being exposed to the stress of a war environment were noted after the Civil War and World Wars I and II.<sup>73,74,75,76,77,78</sup> A high prevalence of PTSD, depression, and substance abuse was found among veterans of the Vietnam War,<sup>79,80</sup> in addition to other personal and social difficulties.<sup>81,82</sup> In a comparison with contemporaries who did not serve in Vietnam, Vietnam veterans also reported more physical symptoms and illnesses,<sup>83</sup> and were much more likely to report a general state of poor or fair health.<sup>84</sup> When these two groups were given medical examinations, few differences were found between them. Other studies have also found a correlation between levels of PTSD symptoms and reported physical health problems;<sup>85,86</sup> however, part of this is expected due to the relation of combat injury to PTSD.

The trauma of armed conflict is not unique in causing or contributing to the development of mental health problems. Very similar findings have been found in groups following natural catastrophes, with higher rates of somatic symptoms reported in populations that have experienced disasters.<sup>87,88</sup> The correlation of PTSD with somatic complaints has been noted in these situations as well.<sup>89</sup>



Studies have found that participation in combat is a risk factor for development of PTSD and other psychiatric problems in veterans.<sup>90,91</sup> Although there were relatively few individuals exposed to combat in the Persian Gulf, there were several other psychologically stressful circumstances present. Significantly higher levels of mental health symptoms were found among deployed as compared to nondeployed personnel in a study involving Army, Navy and Marine reservists, and these symptoms seemed to be correlated with higher levels of stress exposure.<sup>10,94</sup> The handling of human remains is also very stressful and was a part of Persian Gulf experience for some service members. Previous studies have indicated the presence of psychological distress in people exposed to dead bodies following a disaster.<sup>95,96</sup> A comparison of ODS/S participants who handled remains and those who did not found significantly higher levels of intrusive and avoidance symptoms in the former.<sup>97</sup> Eight months following ODS/S, considerable psychopathology was found among a group of Army reservists who served in a war zone and performed graves registration duty.<sup>98</sup> Almost half of these troops met criteria for PTSD, which was strongly associated with evidence of depressive and substance use disorders, and a number expressed concern about somatic symptoms, including difficulty sleeping (50%), feeling nervous or tense (46%), a sense of being overly tired (42%), concentration problems (38%), general aches and pains (38%), and headaches (33%). Higher levels of psychopathology were found among reservists who did graves registration work in-theater versus in the United States.<sup>99</sup> During the Persian Gulf War, Reserve and National Guard units experienced some stressors to a higher degree than active duty members. These include minimal preparation time for deployment, family and vocational disruption, and financial distress resulting from loss of civilian employment.

Findings of Israeli researchers provide further data to indicate that the stress of the Gulf War extended beyond direct combat experiences. Moderate levels of psychological distress were found in many soldiers who were not in direct combat.<sup>100</sup> These difficulties were attributed to a combination of factors, including fear of impending missile attacks, the impression created by the news media that the population of Israel was experiencing acute distress, and a low level of trust in Army authorities.

The presence of these stressors may contribute to our understanding of the considerable percentage of the CCEP population presenting with somatic symptoms previously noted to be characteristic of individuals who have experienced high levels of trauma and natural disaster related stress.

The "environmental threat" model, which addresses community reactions to plausible threats to health, may provide additional explanations for the clinical presentations that are seen in the CCEP population.<sup>101</sup> Widespread public concern emphasized the possible health risks due to environmental exposures and their potential relationships to various health problems Persian Gulf veterans were experiencing. Thus, unexplained symptoms were first attributed to ODS/S service even before thorough medical assessment and evaluations could be performed.

When trying to understand the illnesses being experienced by Gulf War veterans, or illnesses being experienced by any group of people who have been through a traumatic experience, one of the most difficult problems is understanding the higher-than-expected rates of symptoms and illness for which there is as yet no clearly identifiable cause. As has been shown in the CCEP, Gulf War veterans are experiencing real illnesses with real consequences requiring real treatments. We are trying to understand better whether these illnesses are unusual and what the primary influences have been.

Although, there is more work to be done, the results of the CCEP have clarified our understanding of Persian Gulf illnesses by providing diagnostic information derived from extensive evaluation of Gulf War veterans presenting with a variety of symptoms. However, the CCEP does not fully explain what seem to be higher-than-expected rates of some symptoms and illnesses. There are a number of possibilities that, individually or together, deserve further exploration and will help explain what may be higher rates. One possibility is that these are not really higher-than-expected rates for this population and that a comparable population that had not served in the Gulf War would experience similar rates of symptoms and illness. Another possibility is that some of the higher-than-expected rates may result from an amplification of the rate and degree of symptoms and illness by some external influence. This possibility might be tested by examining other groups of people experiencing similar levels of trauma (e.g., natural

disasters, terrorists attacks) and by examining how and to what degree external influences (media, peer groups, families, and other information sources) impact Gulf War veterans' health. A third possibility is that some number of troops in the Gulf contracted an illness that has yet to be identified through further research, although CCEP clinical evidence to date does not support this. While beyond the scope of the CCEP, all three of these possibilities, as well as others, deserve further exploration if we are to fully understand "Persian Gulf illnesses" and initiate interventions to prevent similar illnesses in the future.

Physical and psychological symptoms and manifestations after stressful circumstances are just as real and discomforting as those that result from physical, biological, or chemical stressors. Treatments are available which may serve to relieve many of the painful symptoms that plague some Persian Gulf veterans. In addition to providing routine care for individuals who may be experiencing some difficulties related to their experiences in ODS/S, DoD has established a Specialty Care Center for those who are suffering chronic problems that are not easily treated.

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## **Discussion of Evidence For and Against a Single, Unique Syndrome**

Much of the concern that has focused on the issue of Persian Gulf illnesses has centered around whether or not Gulf War veterans are experiencing a unique illness or syndrome. The CCEP was established primarily as a clinical program to provide health care to Gulf War veterans, rather than as a research study to resolve this question. However, the results of the CCEP, including the clinical impressions of physicians at multiple centers who have examined over 18,000 patients, corroborated by basic descriptive epidemiologic analysis, provide substantial evidence for concluding that CCEP participants have a variety of different diagnoses with overlapping clinical presentations, rather than a single, unique syndrome. The IOM-CCEP Committee recently released its final report on the CCEP and found that "There is currently no clinical evidence in the CCEP for a previously unknown, serious illness among Persian Gulf veterans. If there were a new or unique illness or syndrome among Persian Gulf veterans that could cause serious impairment in a high proportion of veterans at risk, it would probably be detectable in the population of 10,020 CCEP patients. On the other hand, if an unknown illness were mild or only

affected a small proportion of veterans at risk, it might not be detectable in a case series, no matter how large."<sup>102</sup>

The CCEP is essentially a very large collection of cases representing primarily patients who believe they may be experiencing unusual illnesses that may be related to their Gulf War experience. Case series reports provide insight into emerging occupational and environmental illnesses and can result in clinical recognition of unusual patterns of disease, particularly when the effects are severe and readily identifiable according to clinical presentation. Clinical studies and case reports, although limited because they lack comparison populations, are nonetheless very useful for characterizing illnesses.

The majority of CCEP patients who have presented with various chief complaints (and other symptoms) such as fatigue, headache, joint pain, and sleep disturbances, have received definitive diagnoses in accordance with a diagnostic protocol which exceeds the scope of care usually provided in the primary care settings. CCEP clinicians have identified a wide range of specific diagnoses (i.e., migraine headache, depression, asthma, arthritis, hypertension). However, few if any of the conditions diagnosed to date could be considered specific for any of the many different exposures implicated as potential causes of Persian Gulf illnesses. Thus as a case series, the CCEP has identified a wide spectrum of different clinical conditions rather than any singular, homogenous diagnostic entity.

The fact that the majority of CCEP participants received more than one diagnosis as a result of their clinical evaluation deserves comment. In examining subsets of patients with multiple diagnoses whose primary diagnosis is in one of the four largest disease categories (psychological conditions, musculoskeletal diseases; symptoms, signs, and ill-defined conditions; and respiratory diseases), a rather consistent pattern emerges. These patients most commonly have their initial secondary diagnosis in the same diagnostic category as the first, or in the categories of psychological, musculoskeletal, or ill-defined. Regardless of the primary diagnosis, the distribution of other ICD-9-CM categories occurs in a narrow range at any level in the diagnostic tier. These observations suggest that there is no clinically apparent clustering of diagnoses as relates to a patient's primary ICD-9-CM categorization. Factor analyses, as part of anticipated

epidemiological research studies using sophisticated computer modeling to look at discreet diagnoses, will further characterize the clinical profile of individuals with multiple diagnoses.

Approximately 20% of CCEP patients have conditions which, for classification purposes, fall within a broad and relatively nonspecific residual coding category. These conditions do not meet clinical criteria for classification elsewhere in the ICD-9-CM coding system. These patients have a variety of different conditions that are not clinically unique, are consistent with those seen by physicians in primary care practice, and are not severely disabling. While this group of patients may have relatively nonspecific conditions for the purposes of diagnostic coding, this observation is not unusual, given that about half of all diagnoses in primary care visits do not resolve into codable diagnostic entities.<sup>103</sup>

To date, a generally accepted case definition does not exist for what has been referred to as "Gulf War Syndrome."<sup>4,17,50</sup> While multiple physical and biologic agents have been proposed as a primary cause of Gulf War veterans' illnesses, review of the CCEP diagnostic experience reveals relatively small numbers of the types of clinical conditions that might be expected if hazardous exposures had indeed occurred on a large scale. For example, CCEP participants have few diagnoses involving adverse drug reactions and/or immune dysfunction disorder, pneumoconioses or "dust-related" disorders or pulmonary fibrosis, peripheral neuropathy that might be associated with exposure to solvents or organophosphate-based pesticides, or kidney disease that might be a manifestation of heavy metal toxicity.

The CCEP has not identified any consistent presentation for a well-defined disease or new illness with specific physical or laboratory findings based on review of available clinical data.<sup>51,52,53</sup> Historically, clinical case series have characterized new and emerging syndromes. Legionnaire's disease and toxic shock syndrome are good examples of illnesses that emerged with rather prominent and consistent physical and laboratory findings.<sup>57,58</sup> AIDS is another example, but the clinical presentation was more varied.<sup>59</sup> At the other end of the clinical spectrum are conditions like chronic fatigue syndrome (CFS) and fibromyalgia, which can only be defined by nonspecific symptomatology.<sup>60,61</sup> The symptom-based clinical presentation of some CCEP participants appears to overlap with CFS and fibromyalgia, but relatively few numbers of CCEP participants

meet the definitional criteria for these two conditions. However, psychological symptoms or psychiatric diagnoses are a prominent feature of all three groups.<sup>63</sup>

Somatic symptoms, with no apparent pathophysiological explanation, are commonly reported in military and civilian outpatient settings.<sup>42,104,105,106,107</sup> These somatic symptoms often coexist with well-defined disorders, particularly psychological conditions.<sup>108</sup> When compared with patients with nonsomatic disorders, patients with somatic disorder see ambulatory care providers more frequently.<sup>109,110</sup> Given these findings, it is not unusual to note a sizeable number of people in the CCEP population with ill-defined and psychological conditions.

Illnesses manifested solely by combinations of symptoms with no consistent objective findings on physical examination or positive laboratory abnormalities, and for which an adequate etiologic explanation is yet to be determined, are common in clinical practice and the general population. Such "symptom syndromes" include entities such as irritable bowel syndrome, fibromyalgia, chronic fatigue syndrome (CFS), and depression. A recent study by the Centers for Disease Control and Prevention compared the prevalence of symptoms in Persian Gulf veterans to nondeployed, Persian Gulf-era veterans.<sup>111</sup> Preliminary findings indicated that chronic symptoms, similar to those seen in CCEP participants, were reported more commonly by Persian Gulf veterans than by nondeployed, Persian Gulf-era veterans. Comprehensive medical evaluations by CDC physicians and a review of medical records for 59 Persian Gulf War veterans in the initial case series did not identify any consistent physical or laboratory abnormalities. A case-control study is currently underway to compare symptoms and illnesses in deployed and nondeployed Persian Gulf War service members.

In the CCEP, clinical review and descriptive epidemiologic data have shown relatively little evidence for a unique clinical entity. CCEP participation is not strongly associated with any single demographic category (age, sex, ethnicity, branch of service, or unit of assignment). The major diagnostic categories stratified according to age, sex, and branch of service, show no exclusive relationship to any one variable. The frequency distribution of reported exposures, symptoms, and diagnoses show no marked differences between "high" and "low" participation UICs. The small number of individuals who report lost work days suggest that the majority of

the CCEP participants are not experiencing severely disabling conditions. Determination of the degree to which the CCEP disability experience reflects the overall disability of Persian Gulf veterans is limited by the fact that many Persian Gulf War veterans have separated from the military. In the future, sophisticated statistical techniques, including cluster analysis, might identify whether or not there are previously unidentified patterns of symptoms among CCEP patients. Should an unusual pattern emerge, the clinical significance of such an observation could be further assessed by searching for abnormal physical findings and laboratory results.

In summary, the overall CCEP experience, based on clinical findings of physicians and initial descriptive epidemiologic analysis, shows no evidence for a previously unknown serious illness or syndrome among Gulf War veterans who are participants in the CCEP. However, clearly the Gulf War experience may have been a cofactor in the precipitation or aggravation of certain diagnoses, such as musculoskeletal and psychiatric conditions in some individuals. Based upon the CCEP, DoD concurs with the conclusions of the Institute of Medicine which states: "If there were a new or unique illness or syndrome that could cause serious impairment in a high portion of veterans at risk, it would probably be detectable in a population of 10,020 patients. On the other hand, if an unknown illness were mild or affected only a small proportion of veterans at risk, it might not be detectable in a cases series, no matter how large."<sup>102</sup> However, future research will be needed to determine if CCEP participants are experiencing an unusual pattern of symptoms having clinical significance.

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## **Causality and Health Outcomes**

Finding a definite link between an illness and its cause is often a challenge within medical practice. The process of understanding the relationship between risk factors and illness is often complex. An investigation of disease causation and work-relatedness for any set of illnesses relies on the application and integration of well-conducted epidemiologic studies, environmental monitoring, well-designed toxicologic studies, identification of risk modifiers, and consideration of contributing factors to disease. The concepts of causation may be limited by the science available to prove a solid relationship between a certain exposure and a specific health outcome.

Furthermore, there may be multiple causes of an illness; a set of causes usually involves a complex interplay of agent, environmental, and host factors. Determining a causal relationship becomes even more difficult when there is an inability to validate self-reported exposures in combination with a wide spectrum of sometimes intangible or symptom-based illnesses. However, as our understanding of the pathogenesis and epidemiology of a condition becomes known, the individual factors resulting in a disease begin to become clearer. With respect to the Persian Gulf War, it is possible to correlate some illnesses with ODS/S. For example, the cases of leishmaniasis can be attributed to the Persian Gulf environment. It was the location that brought the host to the vector of disease. Other examples of linking an exposure to an illness include musculoskeletal injuries that occurred in theater and some acute infectious diseases that resulted in upper respiratory or gastrointestinal illnesses. However, as in any clinical setting, illnesses that present with vague or mild symptoms are much more difficult to link to an event or location. It is important to note that many patients in general medical practice, not just CCEP participants, have symptoms that are not the result of a specific disease or other known pathophysiological mechanism. In the final analysis, proof of a causal relationship must be based on rigorous testing and the scientific process.

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## Research Efforts

The CCEP and the VA Persian Gulf Health Registry are providing clinical information about the types of symptoms and illnesses experienced by Gulf War veterans. However these clinical programs are not able to fully characterize the prevalence, incidence, or risk factors of disease related to ODS/S deployment. Therefore, an extensive research program has been initiated by DoD, VA, and HHS to complement the clinical registry findings.<sup>8,112</sup> Among the efforts in progress are a number of major epidemiologic studies being conducted by the Naval Health Research Center, CDC, and the VA. The Naval Health Research Center, San Diego, California (in collaboration with the VA, HHS, and the University of California), is conducting a series of epidemiologic studies of military personnel. Studies include personal interviews and physiologic testing of 750 ODS/S veterans and 1500 nondeployed Gulf-era veterans, analysis of the hospitalization records of 1.2 million service members, and review of pregnancy outcomes



among Gulf War veterans and their spouses. Initial findings from these studies were presented at the American Public Health Association (APHA) conference in October 1995, as discussed earlier in this report. The VA Environmental Epidemiology Service, Washington, DC (in collaboration with DoD and HHS), is conducting a random survey of 15,000 veterans who served in the Persian Gulf and 15,000 "control" era veterans. This mail and telephone survey is designed to describe the symptomatology experienced after Gulf service, assess the current health status of veterans and their family members, including reproductive health, and evaluate potential environmental exposures. The CDC is also conducting a study to determine the prevalence of reported symptomatology, illnesses, and exposures among Persian Gulf service members who list Iowa as their home of record.

Other ongoing research studies are assessing reproductive health, evaluating diagnostic tests for leishmaniasis infection, and studying the health effects of exposure to depleted uranium and possible interactive effects of chemical exposures. This extensive research program will provide a comprehensive evaluation of the health consequences of Persian Gulf service and will contribute to the development of programs to protect the health of military personnel during future deployments.

The information maintained in the CCEP database constitutes a large case series and was not designed to be a research study. Nevertheless, the CCEP database provides valuable descriptive information and, as such, is useful for generating hypotheses for future research. Once Privacy Act provisions ensuring the protection of individual participants have been met, the entire CCEP data set will be placed in a format that will allow access to a broad range of scientific investigators. The DoD anticipates making the CCEP data set available through the National Technical Information Service and the Defense Technical Information Center this year.

# CONCLUSIONS

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The large size of the CCEP cohort and the thoroughness of CCEP examinations provide considerable clinical insight for understanding the nature of illnesses and health complaints being experienced by this group of veterans. However, self-selection of patients, differential eligibility, recall bias, inability to validate self-reported exposures, and lack of an appropriate control group limit the generalization of these findings to other Gulf War veterans.

In general, there appear to be no unique distinguishing characteristics of CCEP participants. CCEP participants served in a large number of units during the Persian Gulf. Preliminary analysis indicates no apparent clustering of CCEP participants on the basis of unit of assignment during the Gulf War. The CCEP participant self-reported exposures span a wide range of occupational and environmental chemical and physical agents, vaccines, and medications. Confirmation of these self-reported exposures was not within the scope of the CCEP, since the primary objective of the exposure questionnaire was to assist the physician in the diagnosis of the patient's medical condition. However, in specific instances, exposures are known to have been limited to relatively small numbers of individuals (e.g., depleted uranium, malaria prophylaxis, and botulinum toxoid).

CCEP participants commonly report a variety of symptoms such as fatigue, joint pain, headache, or sleep disturbances. Review of other studies of patients with similar chronic health complaints seeking primary care in the U.S. indicate that these symptoms are routinely reported and are not unique to CCEP participants. Although the types of symptoms being experienced by CCEP participants are not unique, studies using appropriate control populations will determine whether these symptoms are associated with greater illness in subsets of Persian Gulf veterans than might be expected.

The CCEP has identified a wide range of primary diagnoses commonly seen in clinical practice (e.g., tension headache, migraine headache, fatigue, osteoarthritis, back pain, depression or stress related conditions). The majority of patients have received a primary diagnosis consistent with their chief complaint. Approximately 80% of participants have more than one diagnosis. Using standard ICD-9-CM coding criteria, 51% of the CCEP diagnoses can be categorized as psychological conditions; symptoms, signs, and ill-defined conditions; and musculoskeletal and connective tissue diseases.

Using some caution with NAMCS comparisons can provide a perspective to interpret the CCEP diagnostic experience. The data suggest that the major diagnostic categories may be over-represented in the CCEP. Potential explanations for these differences include, but are not limited to:

- Aggressive "case finding," may have differentially attracted Persian Gulf war veterans with chronic, nonspecific symptoms;
- Overrepresentation of individuals with physical conditions (musculoskeletal injuries) associated with the intense physical demands of military service;
- Detection bias resulting from use of the structured, CCEP examination protocol to diagnose physiologic and psychological conditions that might otherwise not be evident in the course of routine, primary care; and,
- Factors directly related to the Persian Gulf War experience, such as exposure to stressful circumstances, the threat of death and injury from SCUD missile attacks, CBW threat, the harsh physical environment and living conditions, and concerns about the safety of immunizations.

Concern regarding the possible existence of "unexplained illnesses" was a major consideration in the design of the CCEP. Although CCEP physicians have not identified a unique illness or syndrome, 18% of CCEP primary diagnoses can be categorized as symptoms, signs and ill-

defined conditions according to ICD-9-CM coding criteria. Coding of a diagnosis within the category of symptoms, signs and ill-defined conditions primarily reflects limitations in diagnostic and/or coding criteria rather than an impression as to whether or not the condition can be explained. It should be noted that these diagnoses refer to a variety of conditions (well-defined conditions not classified elsewhere in the ICD-9-CM system, generalized symptoms, nonspecific findings, and abnormal laboratory tests) commonly encountered in primary care medical practice. Physical symptoms in both clinic patients and the general population frequently lack a clear-cut or discrete physical explanation or "cause."

Severe disability, measured in terms of lost workdays and/or participation in the disability evaluation system, is not a major characteristic of CCEP participants. CCEP patients with severe disability may benefit from participation in special programs that focus on rehabilitation, restoration of function, and promotion of general well-being. The DoD has established Specialized Care Centers, staffed by interdisciplinary teams, to provide such programs.

The CCEP has documented symptoms and confirmed diagnoses in over 18,000 individuals. DoD physicians have diagnosed a wide range of various medical conditions commonly seen in general medical practice rather than a single, unique syndrome. The results of the CCEP are consistent with conclusions of a National Institutes of Health Technology Assessment Workshop that among Gulf War veterans "no single disease or syndrome is apparent, but rather multiple illnesses with overlapping symptoms and causes." Results of questionnaires and personal feedback received by CCEP clinicians suggest that CCEP participants have generally been satisfied with the care they have received. DoD will continue to provide comprehensive, high-quality health care to eligible Persian Gulf veterans and will maintain an ongoing search for unique symptom and illness patterns. The Department is committed to an ongoing exchange of health information with other government agencies and Persian Gulf veterans to further understand this important issue.

The Department has implemented a comprehensive medical surveillance program for U.S. Forces deploying to Bosnia. The plan incorporates many of the "lessons learned" from the

Department's experience with the CCEP. Primary elements of the medical surveillance plan include identification of populations at risk, recognition and assessment of hazardous exposures, determination of protective measures, ensuring accurate documentation of medical events, and monitoring of health outcomes. Service members received predeployment health screening to identify individuals with acute or chronic conditions that would disqualify them for deployment. Predeployment briefings focused on anticipated infectious disease threats, prevention of occupational and environmental illness and injuries, and recognition of psychological and social stressors associated with deployment. Combat Stress Units were deployed to Bosnia in recognition of the fact that controlling combat stress is a significant factor in sustaining a healthy deployed fighting force. Emphasis is being placed on improving commanders' and units' awareness so that they will identify and report stress-related complaints and/or symptoms during the deployment. Upon return from deployment to Bosnia, service members will receive a post-deployment briefing and a medical evaluation that includes a standardized psychosocial assessment. Additionally, stress management programs will be made available to service members and their families. This surveillance plan and its related programs may serve to prevent or reduce the development of illnesses, psychosocial problems, and other adverse consequences resulting from combat and military operations involving deployments.

# APPENDIX A: RELATED DoD ACTIVITIES

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## Persian Gulf "Declassification and Investigation" Effort

The Department of Defense, in an unprecedented initiative to declassify and share with the public all possible medical, intelligence, and operational information that could have affected the health of personnel involved in the Persian Gulf War, established the Persian Gulf Investigation Team. This team consists of personnel with expertise in medicine, investigation, military intelligence, and military operations. The Investigation Team has been set up to integrate and analyze classified, declassified, and unclassified material in order to explore all reasonable or possible connections to illnesses experienced by Gulf War veterans. The team is also responsible for a toll-free hotline, 1-800-472-6719, which allows veterans an opportunity to give firsthand accounts of events or environmental exposures that they feel might be related to illnesses experienced by Gulf War veterans. The hotline also accepts theories and research on this subject from health care providers. Finally, the team coordinates with all other Department of Defense, other government, and non-governmental agencies to share information on the illnesses of these veterans. Additionally, representatives from the intelligence community, the Services, the Joint Staff and the Unified Commands are collecting and processing millions of pages of Gulf War correspondence and records. As this material is declassified, it is placed on the Internet at GulfLINK (<http://www.dtic.dla.mil:80/gulflink>) along with many other documents pertaining to the subject of illnesses in Persian Gulf War veterans. The declassification program, the GulfLINK site on the Internet, and the Investigation Team are other parts of DoD's effort to "leave no stone unturned" in answering the many questions posed by the government, ill veterans, researchers, and the general public.

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## DoD Research Efforts

The following list contains only DoD research projects that are Persian Gulf related. Integrated with DoD's research studies are numerous other studies within the Departments of Veterans Affairs and Health and Human Services. In addition to the intramural research programs currently under way within DoD, VA, and HHS, there is also an extramural research program involving Persian Gulf health-related issues that will begin by the middle of 1996. A complete listing of all Persian Gulf related research will be published by the Persian Gulf Veterans' Coordinating Board.

Project ID	Expected Completion Date	Project Title	Summary/ Information
1a-g	FY-99	Epidemiologic Studies of Morbidity Among Gulf War Veterans: A Search for Etiologic Agents and Risk Factors (A group of seven epidemiologic studies)	To characterize the prevalence of symptoms, illness, hospitalizations, infertility, and adverse reproductive outcomes among Gulf War veterans; to determine whether exposures or risk factors unique to military service in the Gulf War are associated with illness
2	4th Qtr. FY-97	Physiological and Neuro-behavioral Effects in Rodents from Exposure to Pyridostigmine, Fuels, and DEET	To evaluate the potential of a simulated PGW exposure consisting of multiple exposures, alone and in combination with an imposed psychological stressor, to induce biological effects in rats. To evaluate effects for similarities with symptoms of PGI. To determine whether the rodent model can reproduce symptoms reported in PGW veterans
4	May 1994	The General Well-Being of Gulf War Era Service Personnel from the States of Pennsylvania and Hawaii: A Survey	Assess the general sense of well-being of Gulf War era veterans in the States of Hawaii and Pennsylvania. Completed.
5	Sep 1998	Health Hazards of Operational Stress	To determine risk factors for the development of physical and psychological symptoms in response to operational stress.
7a	Sep. 1997	Health Risk Assessment of Embedded Depleted Uranium: Behavior, Physiology, Histology, and Biokinetic Modeling	To evaluate health risks associated with tissue-embedded DU fragments by studying behavioral, physiological, and histological consequences of implanted DU in a rodent model

Project ID	Expected Completion Date	Project Title	Summary/ Information
7b	Oct. 1998	Carcinogenicity of Depleted Uranium Fragments	To assess the carcinogenic risks associated with long-term exposure to DU-containing shrapnel in wounds
8a	Awaiting Funding	Serologic Diagnosis of Viscerotropic Leishmaniasis	To develop a reliable serologic test for viscerotropic leishmaniasis
8b	Awaiting Funding	Development of a <i>Leishmania</i> skin test antigen (LSTA)	To develop a reliable skin test for <i>Leishmania</i> infection
10	Mar. 1995	Acute Oral Toxicity Study involving PB, DEET, and permethrin	To determine potential toxic interactions when pyridostigmine bromide, permethrin, and DEET are given concurrently to male rats by gavage to analyze concerns about possible synergism of pyridostigmine taken by service members in ODS to protect them against potential nerve agent exposure and the insecticides permethrin and DEET, which were used by SM's in ODS. Complete.
11	FY-96	Male/Female Differential Tolerances to Pyridostigmine Bromide	To determine whether males and females have different tolerances to doctrinal dose (30 mg every 8 hrs) of pyridostigmine bromide
12	Multiple Products With Different Schedules For Each	Forward Deployable Diagnostics for Infectious Diseases	To develop a series of simple diagnostic assays suitable for forward deployed preventive medicine teams, Area Medical, and Forward Laboratories
13	1998	Effects of Persian Gulf War Service on Military Working Dogs	To test the hypothesis that there will be no differences in pathologic diagnoses between a PG MWD cohort and a matched comparison group never deployed to SWA. If hypothesis not supported, then possibility exists that differences in diagnoses between the two cohorts may be due to deployment to SWA and the dates of deployment and location in PG theater will be compared among the PG MWDs, and conceivably to those of PG veterans
14	FY-96	Risk Factors among U.S. Army Soldiers for Enrolling in the Department of Veterans Affairs Gulf War Registry	To determine the presence of unique characteristics of Army personnel enrolled in the VA Registry of Persian Gulf veterans



Project ID	Expected Completion Date	Project Title	Summary/ Information
15	Jan. 1995	Comparative Mortality among U.S. Military Personnel Worldwide During Operations Desert Shield and Desert Storm	To characterize disease and nonbattle injury mortality experience of U.S. military personnel during ODS/S. To determine whether U.S. military personnel deployed to SW Asia had a higher rate of death than U.S. military personnel who did not deploy. Completed.
16	Feb. 1994	Kuwait Oil Fire Health Risk Assessment	To characterize both the carcinogenic and noncarcinogenic health risks to DoD troops and civilian employees exposed to the environment affected by the oil fires during and after ODS. Preliminary risk assessment completed. Risk by Unit analyses ongoing.
17	May 1992	Retrospective Studies Involving Military Use of Pyridostigmine as a Pretreatment for Nerve Agent Poisoning	To obtain safety data for New Drug Application with the FDA to help perform retrospective evaluation of effects of pyridostigmine use in the Persian Gulf. Data collection ongoing.
18	Late 1996	Kuwait Oil Fires Troop Exposure Assessment Model	To respond to Public Law 102-190, section 734, by characterizing the potential carcinogenic and non-carcinogenic health risks to U.S. military personnel exposed to the environment affected by the oil well fires during and after ODS
20	July 1995	A Statistical Study Correlating the Reported Cases of Gulf War Syndrome to Battlefield Locations of Afflicted U.S. Army Personnel During the Iraq-Kuwait War, Part 1, Method to Relate Troop Deployment and the Reported Cases of Gulf War Syndrome and Probable Incidence of Maladies Defined by the International Code of Diseases ICD-9-CM	To devise a procedure for counting the collections of symptoms and diagnoses of veterans' illnesses and relating them to the U.S. military grid system locations in the Kuwait-Iraq-Saudi Arabian theater of operations
21	Dec. 1996	Possible Relationship between Multiple Chemical Sensitivity of Insect Repellent (DEET) and Carbamate (Pyridostigmine) in Gulf War Veterans' Illnesses; Study of Variability in Pyridostigmine Inhibition of Blood Cholinesterases in Healthy Adults and Individuals with Symptoms Following Participation in ODS	To determine whether symptoms exhibited by some GW veterans are due to altered pyridostigmine inhibition kinetics and/or the synergistic effect of insect repellent on pyridostigmine inhibition

<b>Project ID</b>	<b>Expected Completion Date</b>	<b>Project Title</b>	<b>Summary/ Information</b>
<b>22</b>	May 1998	Chronic Organophosphorus Exposure and Cognition	To evaluate the effects of low-level sub-chronic exposure to an organophosphorus cholinesterase inhibitor on normal cognitive function in animal models. LTGs are to identify underlying mechanisms of organic brain damage caused by environmental toxins and to develop treatment strategies to improve memory/cognitive performance in affected patients
<b>23</b>	Sep 1998	Acute and Long-Term Impact of Deployment to Southwest Asia on the Physical and Mental Health of Soldiers and Their Families	To determine the impact of deployment to SWA on the health of soldiers and their families

[illegible]

# APPENDIX B: METHODS

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## Clinical Evaluation Process

All Military Health Services System (MHSS) eligible beneficiaries are eligible for the CCEP program. These include:

- Persian Gulf War veterans now on active duty or retired;
- Members on full-time Active Guard/Reserve program who are PGW veterans;
- PGW veterans who are members of the Reserve components who are placed on orders by the relevant unit or Reserve Headquarters;
- Family members (spouses, children, etc.) who are eligible for DoD health care;
- DoD civilians (current and former) if eligible in accordance with Civilian Personnel Guidance.

Participants enroll in CCEP either by calling a toll-free number (1-800-796-9699), which provides information and referrals to individuals requesting medical evaluations, or by contacting their local military medical treatment facility (MTF). The MTF commander is responsible for all aspects of the CCEP at the MTF level. Working for the MTF commander, the MTF CCEP physician is responsible for the medical issues and for ensuring that the examinations conducted are consistent with the established CCEP protocol. The MTF CCEP physician is required to be a board-certified family practitioner or specialist in internal medicine.

Developed by a multidisciplinary team of DoD and VA medical specialists, the CCEP provides a two-phase, comprehensive medical evaluation. Phase I is conducted at the local MTF and consists of a history and medical examination comparable in scope and thoroughness to an in-patient hospital admissions evaluation. The medical review includes questions about family history, health, occupation, unique exposures in the Gulf War, and a structured review of

symptoms. Health care providers specifically inquire about the symptoms and Persian Gulf exposures listed on the CCEP Provider-Administered Patient Questionnaire. The medical examination focuses on patients' symptoms and health concerns and includes standard laboratory tests (complete blood count, urinalysis, serum chemistries) and other tests as clinically indicated.

Individuals who require additional evaluation after completing the MTF-level Phase I evaluation and appropriate consultations may be referred to one of 14 Regional Medical Centers (RMCs) for Phase II evaluations. RMCs are tertiary care medical centers that have representation from most major medical disciplines. Phase II evaluations consist of symptom-specific examinations, additional laboratory tests, and specialty consultations according to the prescribed protocol.

For CCEP participants suffering from chronic, debilitating symptoms, the DoD has established a Specialized Care Center (SCC) at Walter Reed Army Medical Center (Eastern Region), and has planned a second center, currently scheduled to open in mid 1996, at Wilford Hall Medical Center (Western Region). The SCC provides additional evaluation, care, and rehabilitation through an intensive three-week evaluation and care program designed to restore participants to a maximum state of health and fitness. A multidisciplinary team of physicians from various specialties, behavioral health psychologists, nurses, and physical and occupational therapists comprise the staff of the SCCs. The treatment program is modeled after multidisciplinary pain centers, which have proven effective in treating patients with chronic, debilitating diseases.

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## **Institute of Medicine (IOM)**

The IOM, at the request of the DoD, formed a panel of experts in epidemiology, occupational medicine, internal medicine, infectious diseases, psychiatry/psychology, community mental health, allergy/immunology, and other disciplines to review the CCEP. This panel assesses the effectiveness of the CCEP and makes recommendations on the means of improving the collection and maintenance of information.

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## **Data Management Process**

The original documentation from a CCEP examination is placed into the participant's health record by the MTF conducting the examination. Each MTF maintains a copy of the evaluation record and forwards a copy to the DoD CCEP Program Management Team (PMT) in Falls Church, Virginia.

Once received by the CCEP PMT, the records are logged in and delivered to the CCEP contractor, who places the record into the CCEP automated tracking system, assigns it a tracking number, and puts the record through a quality assurance (QA) procedure. This process includes verification of completeness of the record and ensures valid diagnostic coding in accordance with International Classification of Diseases-Ninth Revision, Clinical Modification (ICD-9-CM) standards. Records failing the QA procedure are delivered to a records research team, which contacts the RMC to gather needed information and, upon receipt, returns the completed record to the QA review team.

In order to ensure database validity, personnel from the RMCs periodically visit the contractor site and perform a line-by-line verification of all complete, in-process, and deficient records for their regions. The contractor provides a daily count and a weekly total of complete records by MTF and DoD region to the CCEP PMT.

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## **Quality Control Procedures**

Data, initially entered into a relational database, were translated into a statistical package data set to be reviewed and analyzed. Missing or inconsistent data items and data outside of realistic ranges were edited as appropriate. Tests, such as gender being consistent with gender-specific diagnostic codes, were run to reveal illogical relationships among fields. Tests were run on each data field reporting the frequency of each value observed for the data field being examined.

Missing demographic data was replaced using master files from the Defense Manpower Data Center (DMDC).

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## **Analytic Approach**

### **Demographics**

CCEP participants can be divided into several categories:

- All individuals on active duty during the Gulf War,
- Reserve/Guard personnel mobilized during the Gulf War,
- Active duty, reserve, guard personnel in the Gulf War theater of operations,
- DoD civilians in the Gulf War theater of operations, and
- Family members (spouses and children) of those listed above

This report is based on 18,598 completed evaluations. The primary focus of the results section is the 18,075 military (active, guard, reserve) and civilian participants who were physically located in the theater of operations during the Persian Gulf War. The in-theater CCEP participants have been, to a close approximation, identified by use of a Unit Identification Code (UIC) assigned to each individual through a match of social security numbers with the master files maintained by the DMDC, Monterey, California. The demographics (age, sex, race, rank, service, etc.) of the in-theater 18,075 CCEP participants were compared with those of the total Gulf War military population of 696,530.

Each CCEP participant's date of birth was recorded and used to calculate age. Categorization of age into groups was carried out with ages calculated as of the start of Operation Desert Storm (August 2, 1990). Age categories were: 17 to 20 years of age, 21 to 25 years of age, 26 to 30 years of age, 31 to 35 years of age, and 36 to 65 years of age.

The CCEP data set identified the race and ethnicity of participants. Some racial minorities, such as Native Americans or Asian and Pacific Islanders, were combined into a single category of Other in the statistical data set. The race/ethnicity categories utilized are; White, Black, Hispanic and Other/Unknown (including Asians, Native Americans, and Pacific Islanders).

### **Self-Reported Exposures**

All CCEP participants who were in the theater of operations during ODS/S responded (yes, no, don't know) to a list of possible exposures, including smoke from oil fires; fumes from tent heaters; passive cigarette smoke; pyridostigmine; immunizations against anthrax or botulism; antimalarial medication; ate contaminated food, drank or bathed in contaminated water, ate non-Armed Forces food, drank non-Armed Forces water, and exposure to microwaves. These self-reported exposures were examined according to frequency of occurrence in the total CCEP data set and in various subgroups represented in the CCEP.

### **Physician-Elicited Symptoms**

In the CCEP questionnaire, the dates of onset and duration were designated for 15 specific symptoms categories. Positive responses were recorded in these fields; negative responses left these fields blank. A Yes/No category was created for each of the specified symptoms. A date of onset (Month/Year) was entered if known. In addition, a text field was entered for each subject's chief complaint. As many of these complaints as possible were assigned to 66 separate categories, including the 15 specific symptoms listed on the questionnaire.

### **Diagnoses**

Upon completion of the CCEP examination, each participant is assigned diagnoses (one primary and up to six secondary) that may include the diagnosis of "healthy" in the absence of significant medical problems. Primary diagnoses were examined for frequency of occurrence in the in-theater CCEP participants and for variations in frequency of occurrence among other categories



of individuals in the CCEP. Distributions (categorization) of diagnoses were according to the ICD-9-CM.

The ICD-9-CM is a statistical classification system that arranges the elements of morbidity reporting (clinical diagnoses) into groupings of diseases and injuries according to preestablished criteria. ICD-9-CM was published in 1977 by HHS with guidelines set by the American Hospital Association (AHA) and maintains total compatibility with the international system of ICD-9 established by the World Health Organization (WHO). It is revised and updated annually.

The format for ICD-9-CM is the classification of diseases and injuries into 17 chapters based on the multiple axes of etiology, anatomical site, and circumstances of onset. A three-digit basic code for diseases and injuries is assigned, followed by a decimal point that separates the basic code from a possible fourth-digit subcategory and a fifth-digit subclassification. The principle of hierarchy is used within this five-digit coding system, going from the more specific to the less specific. The grouping of diseases and injuries into chapters, sections, categories, and subcategories provides a workable capacity for statistical morbidity reporting and allows for the systematic tabulation, storage, and retrieval of disease-related data. ICD-9-CM has also become a standard for use by third-party payer systems for the reimbursement of health care costs.

## **Reproductive Outcomes**

Reproductive outcomes were obtained through use of a set of six pairs of questions concerning the participants' self-reported reproductive experiences prior to and after ODS/S service. These fields were used to identify members whose reproductive results had changed after ODS/S service.

## Unit Identification Codes

There were 687,851 individuals deployed to the Persian Gulf for whom unit identification data existed. These individuals were assigned to military units designated by 13,450 unique UICs. The number of deployed personnel assigned to a single UIC varied from one person to several thousand (e.g., an aircraft carrier crew). Additionally, the Air Force used a limited number of large "administrative" UICs (for example one UIC had 20,978 personnel assigned). Of the 18,075 in-theater CCEP participants with completed evaluations, 16,917 had UIC information available. These CCEP participants were assigned to 4,056 different UICs, to which 537,637 service members (77% of the total force) were assigned. It is possible that units with high levels of participation in the CCEP may represent units with different exposures during the Gulf War, or different health experiences since the war. A comparison of the exposures and outcomes may provide insight that is useful in understanding the complaints of Gulf War veterans.

Any definition of low or high CCEP participation is necessarily arbitrary, since there is no information from earlier studies to provide guidance. The approach taken in this report was to examine the distribution of participation rates and to contrast the experiences from the extremes of the distribution. In order to provide for statistical stability, units with fewer than 40 members in the Gulf theater were excluded from consideration. Because the Air Force and the Navy utilize UICs to identify very large units that may include many smaller and discrete units, all units with 1,000 or more members in the Gulf were also excluded.

The number of CCEP participants per UIC was examined. After excluding UICs with fewer than 40 members in the Gulf theater and UICs with 1,000 or more members as described earlier, the distribution of CCEP participant rates was stratified into quintiles. Because the quintile of units with highest participation had substantially more members in the CCEP ( $n=5074$ ) than the lowest quintile ( $n=1043$ ), the second lowest quintile ( $n=1331$ ) was combined with the first. Thus, the comparisons are between the CCEP members in the highest quintile to the combined populations of the two lowest CCEP participation rate quintiles.

## **Self-Reported Lost Workdays**

CCEP participants were asked how many days of work they had lost in the 90 days prior to their medical evaluation. Responses were divided into those with no days lost and those with lost days. Individuals in these categories were compared with respect to demographic characteristics, symptoms, exposures, personal threat experience, and diagnoses.

## **Physical Evaluation Boards**

Physical Evaluation Boards (PEBs) are medical condition evaluation procedure boards accomplished within each of the services when a member develops a medical condition that may preclude the member's ability to perform his or her mission satisfactorily. This information was provided to CCEP by the four services and includes all members who have undergone a PEB since August 1990. The consolidated data set was matched by social security number against the master Persian Gulf War dataset and against the CCEP data set. A comparison of PEB rates of PGW veterans and non-PGW veterans was made and compared to CCEP participant PEB rates.

## **National Ambulatory Medical Care Survey (NAMCS)**

The NAMCS, performed by the National Center for Health Statistics, includes data from a representative sample of physician office visits.<sup>45</sup> NAMCS utilizes a multistage probability sampling design. NAMCS data were recoded to agree in format with the CCEP data set. The data fields used from the NAMCS 1990 set are Age, Sex, and the various diagnostic codes.

## **Program Satisfaction**

Upon the completion of each examination phase or upon declining to participate in the examination process, each participant is requested to answer "yes" or "no" to the following question:

"Were you satisfied with the care you received in the program?"

Additional space is available on the form for the participant to provide narrative comments should he or she desire to do so.

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## **Statistical Analysis**

Statistical analysis included measuring the mean and median of continuous variables and determining the proportion falling into certain levels (such as the proportion with seven or more days lost from work). Categorical variables were assessed in several ways. The ability to accomplish a wide range of statistical analyses (tests) is limited by the fact that the CCEP is a self-selected case series and not a research project containing norms and comparative data. The CCEP can characterize the symptoms and illnesses in PGW veterans and provide substantial clinical evidence for a general assessment of veterans' health status subsequent to the PGW.

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on the completion of each examination phase, a report detailing the results of the examination is provided to the participant. The participant is also provided with a copy of the report.

The report is provided to the participant in the following format:

The report is available on the form for the participant to review and sign. The report should be signed and dated by the participant.

## Statistical Analysis

Statistical analysis included assessing the mean and median of continuous variables, assessing the proportion of categorical variables, and assessing the relationship between variables. The analysis was conducted using the SPSS software package. The results of the analysis are presented in the following tables. The analysis was conducted using the SPSS software package. The results of the analysis are presented in the following tables. The analysis was conducted using the SPSS software package. The results of the analysis are presented in the following tables.

# APPENDIX C: ICD-9-CM CODE DISTRIBUTION (Primary Diagnosis)

ICD-9 CM Subcategories*	ICD-9	Frequency	Percent
<b>Infectious Diseases</b>			
INTESTINAL INFECTIOUS DISEASES	(001-009)	17	0.1
TUBERCULOSIS	(010-018)	2	<.05
ZOONOTIC BACTERIAL DISEASES	(020-027)	2	<.05
OTHER BACTERIAL DISEASES	(030-041)	9	<.05
HUMAN IMMUNODEFICIENCY VIRUS (HIV) INFECTION	(042)	3	<.05
POLIOMYELITIS AND OTHER NON-ARTHROPOD-BORNE VIRAL DISEASES OF CENTRAL NERVOUS SYSTEM	(045-049)	2	<.05
VIRAL DISEASES ACCOMPANIED BY EXANTHEM	(050-057)	10	0.1
ARTHROPOD-BORNE VIRAL DISEASES	(060-067)	0	0.0
OTHER DISEASES DUE TO VIRUSES AND CHLAMYDIAE	(070-079)	85	0.5
RICKETTSIOSIS AND OTHER ARTHROPOD-BORNE DISEASES	(080-088)	12	0.1
SYPHILIS AND OTHER VENEREAL DISEASES	(090-099)	6	<.05
OTHER SPIROCHETAL DISEASES	(100-105)	0	0.0
MYCOSES	(110-118)	260	1.4
HELMINTHIASES	(120-129)	1	<.05
OTHER INFECTIOUS AND PARASITIC DISEASES	(130-136)	60	0.3
LATE EFFECTS OF INFECTIOUS AND PARASITIC DISEASES	(137-139)	1	<.05
<b>TOTAL</b>		<b>470</b>	<b>2.6</b>
<b>Neoplasms</b>			
MALIGNANT NEOPLASM OF LIP, ORAL CAVITY, AND PHARYNX	(140-149)	0	0.0
MALIGNANT NEOPLASM OF DIGESTIVE ORGANS AND PERITONEUM	(150-159)	1	<.05
MALIGNANT NEOPLASM OF RESPIRATORY AND INTRATHORACIC ORGANS	(160-165)	3	<.05
MALIGNANT NEOPLASM OF BONE, CONNECTIVE TISSUE, SKIN, AND BREAST	(170-176)	11	0.1
MALIGNANT NEOPLASM OF GENITOURINARY ORGANS	(179-189)	7	<.05
MALIGNANT NEOPLASM OF OTHER AND UNSPECIFIED SITES	(190-199)	8	<.05
MALIGNANT NEOPLASM OF LYMPHATIC AND HEMATOPOIETIC TISSUE	(200-208)	22	0.1
BENIGN NEOPLASMS	(210-229)	73	0.4
CARCINOMA IN SITU	(230-234)	2	<.05
NEOPLASMS OF UNCERTAIN BEHAVIOR	(235-238)	15	0.1
NEOPLASMS OF UNSPECIFIED NATURE	(239)	2	<.05
<b>TOTAL</b>		<b>144</b>	<b>0.8</b>
<b>Endocrine, Nutritional &amp; Metabolic Disorders</b>			
DISORDERS OF THYROID GLAND	(240-246)	126	0.7
DISEASES OF OTHER ENDOCRINE GLANDS	(250-259)	81	0.4
NUTRITIONAL DEFICIENCIES	(260-269)	5	<.05
OTHER METABOLIC AND IMMUNITY DISORDERS	(270-279)	152	0.8
<b>TOTAL</b>		<b>364</b>	<b>2.0</b>

<b>ICD-9 CM Subcategories*</b>	<b>ICD-9</b>	<b>Frequency</b>	<b>Percent</b>
<b>Diseases of the Blood &amp; Blood Forming Organs</b>			
DISEASES OF THE BLOOD & BLOOD FORMING ORGANS	(280-289)	97	0.5
<b>TOTAL</b>		<b>97</b>	<b>0.5</b>
<b>Psychoses &amp; Mental Disorders</b>			
ORGANIC PSYCHOTIC CONDITIONS	(290-294)	105	0.6
OTHER PSYCHOSES	(295-299)	368	2.0
NEUROTIC DISORDERS, PERSONALITY DISORDERS, AND OTHER NONPSYCHOTIC MENTAL DISORDERS	(300-316)	2847	15.8
MENTAL RETARDATION	(317-319)	1	<.05
<b>TOTAL</b>		<b>3321</b>	<b>18.4</b>
<b>Diseases of the Nervous System &amp; Sensory Organs</b>			
INFLAMMATORY DISEASES OF THE CENTRAL NERVOUS SYSTEM	(320-326)	1	<.05
HEREDITARY AND DEGENERATIVE DISEASES OF THE CENTRAL NERVOUS SYSTEM	(330-337)	40	0.2
OTHER DISORDERS OF THE CENTRAL NERVOUS SYSTEM	(340-349)	603	3.3
DISORDERS OF THE PERIPHERAL NERVOUS SYSTEM	(350-359)	149	0.8
DISORDERS OF THE EYE AND ADNEXA	(360-379)	99	0.5
DISEASES OF THE EAR AND MASTOID PROCESS	(380-389)	137	0.8
<b>TOTAL</b>		<b>1029</b>	<b>5.7</b>
<b>Diseases of the Circulatory System</b>			
ACUTE RHEUMATIC FEVER	(390-392)	2	<.05
CHRONIC RHEUMATIC HEART DISEASE	(393-398)	1	<.05
HYPERTENSIVE DISEASE	(401-405)	194	1.1
ISCHEMIC HEART DISEASE	(410-414)	35	0.2
DISEASES OF PULMONARY CIRCULATION	(415-417)	2	<.05
OTHER FORMS OF HEART DISEASE	(420-429)	75	0.4
CEREBROVASCULAR DISEASE	(430-438)	15	0.1
DISEASES OF ARTERIES, ARTERIOLES, AND CAPILLARIES	(440-448)	29	0.2
DISEASES OF VEINS AND LYMPHATICS, AND OTHER DISEASES OF CIRCULATORY SYSTEM	(451-459)	43	0.2
<b>TOTAL</b>		<b>396</b>	<b>2.2</b>
<b>Diseases of the Respiratory System</b>			
ACUTE RESPIRATORY INFECTIONS	(460-466)	26	0.1
OTHER DISEASES OF THE UPPER RESPIRATORY TRACT	(470-478)	619	3.4
PNEUMONIA AND INFLUENZA	(480-487)	3	<.05
CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND ALLIED CONDITIONS	(490-496)	506	2.8
PNEUMOCONIOSES AND OTHER LUNG DISEASES DUE TO EXTERNAL AGENTS	(500-508)	2	<.05
OTHER DISEASES OF RESPIRATORY SYSTEM	(510-519)	73	0.4
<b>TOTAL</b>		<b>1229</b>	<b>6.8</b>
<b>Diseases of the Digestive System</b>			
DISEASES OF ORAL CAVITY, SALIVARY GLANDS, AND JAW	(520-529)	58	0.3
DISEASES OF ESOPHAGUS, STOMACH, AND DUODENUM	(530-537)	472	2.6
APPENDICITIS	(540-543)	1	<.05
HERNIA OF ABDOMINAL CAVITY	(550-553)	22	0.1

ICD-9 CM Subcategories*	ICD-9	Frequency	Percent
NONINFECTIOUS ENTERITIS AND COLITIS	(555-558)	187	1.0
OTHER DISEASES OF INTESTINES AND PERITONEUM	(560-569)	337	1.9
OTHER DISEASES OF DIGESTIVE SYSTEM	(570-579)	54	0.3
<b>TOTAL</b>		<b>1131</b>	<b>6.3</b>
<b>Diseases of the Genitourinary System</b>			
NEPHRITIS, NEPHROTIC SYNDROME, AND NEPHROSIS	(580-589)	12	0.1
OTHER DISEASES OF URINARY SYSTEM	(590-599)	65	0.4
DISEASES OF MALE GENITAL ORGANS	(600-608)	95	0.5
DISORDERS OF BREASTS	(610-611)	7	<.05
INFLAMMATORY DISEASES OF FEMALE PELVIC ORGANS	(614-616)	4	<.05
OTHER DISORDERS OF FEMALE GENITAL TRACT	(617-629)	50	0.3
<b>TOTAL</b>		<b>233</b>	<b>1.3</b>
<b>Complications of Pregnancy &amp; Childbirth</b>			
ECTOPIC AND MOLAR PREGNANCY	(630-633)	0	0.0
OTHER PREGNANCY WITH ABORTIVE OUTCOME	(634-639)	1	<.05
COMPLICATIONS MAINLY RELATED TO PREGNANCY	(640-648)	2	<.05
NORMAL DELIVERY, AND OTHER INDICATIONS FOR CARE IN PREGNANCY, LABOR, AND DELIVERY	(650-659)	0	0.0
COMPLICATIONS OCCURRING MAINLY IN THE COURSE OF LABOR AND DELIVERY	(660-669)	0	0.0
COMPLICATIONS OF THE PUERPERIUM	(670-676)	0	0.0
LATE EFFECT OF COMPLICATION OF PREGNANCY, CHILDBIRTH, AND THE PUERPERIUM (NON-SPEC DX)	(677-677)	0	0.0
<b>TOTAL</b>		<b>3</b>	<b>&lt;.05</b>
<b>Diseases of Skin &amp; Subcutaneous Tissue</b>			
INFECTIONS OF SKIN AND SUBCUTANEOUS TISSUE	(680-686)	17	0.1
OTHER INFLAMMATORY CONDITIONS OF SKIN AND SUBCUTANEOUS TISSUE	(690-698)	513	2.8
OTHER DISEASES OF SKIN AND SUBCUTANEOUS TISSUE	(700-709)	595	3.3
<b>TOTAL</b>		<b>1125</b>	<b>6.2</b>
<b>Diseases of the Musculoskeletal System</b>			
ARTHROPATHIES AND RELATED DISORDERS	(710-719)	1860	10.3
DORSOPATHIES	(720-724)	680	3.8
RHEUMATISM, EXCLUDING THE BACK	(725-729)	658	3.6
OSTEOPATHIES, CHONDROPATHIES, AND ACQUIRED MUSCULOSKELETAL DEFORMITIES	(730-739)	109	0.6
<b>TOTAL</b>		<b>3307</b>	<b>18.3</b>
<b>Congenital Anomalies</b>			
CONGENITAL ANOMALIES	(740-759)	39	0.2
MATERNAL CAUSES OF PERINATAL MORBIDITY AND MORTALITY	(760-763)	0	0.0
<b>TOTAL</b>		<b>39</b>	<b>0.2</b>
<b>Perinatal Conditions</b>			
OTHER CONDITIONS ORIGINATING IN THE PERINATAL PERIOD	(764-779)	2	<.05
<b>TOTAL</b>		<b>2</b>	<b>&lt;.05</b>



ICD-9 CM Subcategories*	ICD-9	Frequency	Percent
<b>Symptoms, Signs &amp; Ill-Defined Conditions</b>			
SYMPTOMS	(780-789)	3125	17.3
NONSPECIFIC ABNORMAL FINDINGS	(790-796)	103	0.6
ILL-DEFINED AND UNKNOWN CAUSES OF MORBIDITY AND MORTALITY	(797-799)	11	0.1
<b>TOTAL</b>		<b>3239</b>	<b>17.9</b>
<b>Injury &amp; Poisoning</b>			
FRACTURE OF SKULL	(800-804)	0	0.0
FRACTURE OF NECK AND TRUNK	(805-809)	1	<.05
FRACTURE OF UPPER LIMBS	(810-819)	2	<.05
FRACTURE OF LOWER LIMBS	(820-829)	0	<.05
DISLOCATION	(830-839)	10	0.1
SPRAINS AND STRAINS OF JOINTS AND ADJACENT MUSCLES	(840-848)	81	0.4
INTRACRANIAL INJURY, EXCLUDING THOSE WITH SKULL FRACTURE	(850-854)	0	0.0
INTERNAL INJURY OF CHEST, ABDOMEN, AND PELVIS	(860-869)	1	<.05
OPEN WOUND OF HEAD, NECK, AND TRUNK	(870-879)	0	0.0
OPEN WOUND OF UPPER LIMB	(880-887)	1	<.05
OPEN WOUND OF LOWER LIMB	(890-897)	0	0.0
INJURY TO BLOOD VESSELS	(900-904)	0	0.0
LATE EFFECTS OF INJURIES, POISONINGS, TOXIC EFFECTS, AND OTHER EXTERNAL CAUSES	(905-909)	5	<.05
SUPERFICIAL INJURY	(910-919)	4	<.05
CONTUSION WITH INTACT SKIN SURFACE	(920-924)	0	0.0
CRUSHING INJURY	(925-929)	0	0.0
EFFECTS OF FOREIGN BODY ENTERING THROUGH ORIFICE	(930-939)	0	0.0
BURNS	(940-949)	0	0.0
INJURY TO NERVES AND SPINAL CORD	(950-957)	2	<.05
CERTAIN TRAUMATIC COMPLICATIONS AND UNSPECIFIED INJURIES	(958-959)	7	<.05
POISONING BY DRUGS, MEDICINAL, AND BIOLOGICAL SUBSTANCES	(960-979)	0	0.0
TOXIC EFFECTS OF SUBSTANCES CHIEFLY NONMEDICINAL AS TO SOURCES	(980-989)	1	<.05
OTHER AND UNSPECIFIED EFFECTS OF EXTERNAL CAUSES	(990-995)	21	0.1
COMPLICATIONS OF SURGICAL AND MEDICAL CARE, NOT ELSEWHERE CLASSIFIED	(996-999)	2	<.05
<b>TOTAL</b>		<b>141</b>	<b>0.8</b>
<b>Supplementary Factors</b>			
HIV POSITIVE, NOT OTHERWISE SPECIFIED	(V08.0)	1	<.05
HISTORY OF MALIGNANT NEOPLASM OF THYROID	(V10.87)	1	<.05
HISTORY OF NEUROSIS	(V11.2)	1	<.05
HISTORY OF INFECTIOUS AND PARASITIC DISEASES	(V12.0)	6	<.05
HISTORY OF DISEASES OF BLOOD AND BLOOD FORMING ORGANS	(V12.3)	3	<.05
HISTORY OF DISEASES OF RESPIRATORY SYSTEM	(V12.6)	1	<.05
HISTORY OF DISEASES OF SKIN AND SUBCUTANEOUS TISSUE	(V13.3)	1	<.05
HISTORY OF OTHER MUSCULOSKELETAL DISORDERS	(V13.5)	1	<.05
NORMAL PREGNANCY	(V22.2)	3	<.05

ICD-9 CM Subcategories*	ICD-9	Frequency	Percent
UNSPECIFIED MENTAL OR BEHAVIORAL PROBLEMS	(V40.9)	1	<.05
MARITAL PROBLEMS	(V61.1)	5	<.05
OTHER OCCUPATIONAL CIRCUMSTANCES OR MALADJUSTMENT	(V62.2)	4	<.05
INTERPERSONAL PROBLEMS, NOT ELSEWHERE CLASSIFIED	(V62.81)	1	<.05
OTHER PSYCHOLOGICAL OR PHYSICAL STRESS, NOT ELSEWHERE CLASSIFIED	(V62.89)	3	<.05
PERSON WITH FEARED COMPLAINT IN WHOM NO DIAGNOSIS WAS MADE	(V65.5)	1762	9.7
LACK OF PHYSICAL EXERCISE	(V69.0)	1	<.05
OBSERVATION FOR OTHER SUSPECTED MENTAL CONDITIONS	(V71.09)	8	<.05
OBSERVATION FOR OTHER SPECIFIED SUSPECTED CONDITIONS	(V71.8)	8	<.05
OBSERVATION FOR UNSPECIFIED SUSPECTED CONDITIONS	(V71.9)	1	<.05
<b>TOTAL</b>		<b>1805</b>	<b>10.0</b>
<b>TABLE TOTAL</b>		<b>18,075</b>	<b>100</b>

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# APPENDIX D: GLOSSARY OF ACRONYMS

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<b>APHA</b>	American Public Health Association
<b>CARC</b>	Chemical Agent Resistant Coating
<b>CBW</b>	Chemical and Biological Warfare
<b>CCEP</b>	Comprehensive Clinical Evaluation Program
<b>CW</b>	Chemical Warfare
<b>DNBI</b>	Disease Non-Battle Injury
<b>DoD</b>	Department of Defense
<b>DSB</b>	Defense Science Board
<b>DU</b>	Depleted Uranium
<b>FDA</b>	Food and Drug Administration
<b>HHS</b>	Department of Health and Human Services
<b>IOM</b>	Institute of Medicine
<b>MHSS</b>	Military Health Services System
<b>MTF</b>	Medical Treatment Facility
<b>NAMCS</b>	National Ambulatory Medical Care Survey
<b>NIH</b>	National Institutes of Health
<b>ODS/S</b>	Operations Desert Storm/Shield
<b>PGW</b>	Persian Gulf War
<b>PMT</b>	Program Management Team
<b>PTSD</b>	Posttraumatic Stress Disorder
<b>RMC</b>	Regional Medical Center

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SCC

UIC

USUHS

VA

Specialized Care Center

Unit Identification Code

Uniformed Services University of the Health Sciences

Department of Veterans Affairs

APHA	American Public Health Association
CAB	Chemical Agent Resistant Coating
CBW	Chemical and Biological Warfare
CCF	Comprehensive Clinical Evaluation Program
CV	Chemical Warfare
DAH	Disease Non-Hosts Injury
DoD	Department of Defense
DSB	Defense Science Board
DI	Depleted Uranium
FDA	Food and Drug Administration
HHS	Department of Health and Human Services
ICM	Institute of Medicine
IHHS	Military Health Services System
ITE	Medical Treatment Facility
NAMCS	National Ambulatory Medical Care Survey
NIH	National Institutes of Health
ODM	Operations Desert Storm/Desert Shield
PGW	Persian Gulf War
PMT	Program Management Team
PTSD	Posttraumatic Stress Disorder
RAMC	Regional Medical Center

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